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CONTENTS

No. 1

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Page

MITUO SATÔ

Notes on the Finger-like Pectoral Fins in Three Japanese Fishes. . 1

MASATO TAHARA

Further Studies on the Embryogeny of *Torreya*. 9

SENJI TANITA

Calcareous Sponges Collected in the Kantô District, Japan. 17

SENJI TANITA

Key to all the Described Species of the Genus *Leucosolenia* and Their Distribution. 71

YÔNOSUKE OKADA

Study of the Filamentous Fungi of the Soil of Solfatara. 95

No. 2

(Published December 15th, 1942)

SENJI TANITA

Report on the Calcareous Sponges Obtained by the Zoological Institute and Museum of Hamburg. 105

MASAYUKI NAGAO

Studies on the Growth Hormones of Plants. V. Polar Rootlet Formation on Root Segments Cultured under Sterile Conditions. . . 137

MUTSUO KATÔ

On the Nectar-Cropping Activity of an Andrenid *Halictus Katoi* (in Lit.), Widely Distributed at Mt. Hakkôda. 159

TOSHIO OHUYE

On the Blood Corpuscles and the Blood Formation in *Phoronis*. . . 167

TOSHIO OHUYE

On the Blood Corpuscles and Hemopoiesis of a Nemertean, *Lineus fuscoviridis*, and of a Sipunculus, *Dendrostoma minor*. 187

Makoto Toriumi

Studies on Freshwater Bryozoa of Japan. III. Freshwater Bryozoa of Hokkaidô 197

Makoto Toriumi

Studies on Freshwater Bryozoa of Japan. IV. Freshwater Bryozoa of Taiwan (Formosa). 207

No. 3

(Published April 30th, 1943)

Yosinori Sugihara

Embryological Observations on *Keteleeria Davidiana* Beissner var. *formosana* Hayata 215

Tametake Nagano

Physiological Studies on the Pigmentary System of Crustacea. I. The Color Change of a Shrimp *Paratya compressa* (de Haan). 223

Makoto Toriumi

Studies on Freshwater Bryozoa of Japan. V. The Variations Occurring in the Statoblasts and in the Number of the Tentacles of *Cristatella mucedo* Cuvier. 247

Mutsuo Katô

Ecological Notes on the Activities of Some Insects Coming to the Flowers of "Yatude", *Fatsia japonica*, with Special Reference to the Ecological Importance of the Solar Radiant Energy. (Diurnal Rhythm of Activities in Insects and its Environmental Conditions. No. XII) 255

Keizo Hosoi

Cystine in the Amino Acid Fractions of Protein and the Reaction of Cystine and Cysteine to Phosphotungstic Acid. 263

Huzio Utinomi

Caprellids Obtained in Onagawa Bay, Northern Japan. 271

Huzio Utinomi

Report of the Biological Survey of Mutsu Bay. 37. Caprellids from Asamushi. 281

Tomio Kakukawa

Weitere Untersuchungen über den Askorbinsäuregehalt der Krautpflanzen, mit besonderer Berücksichtigung der Schattenpflanzen... 289

Page

TOMIO KAKUKAWA

Schwankungen des Gehalts an Askorbinsäure und Kohlenhydraten in Pflanzenblättern während der verschiedenen Tageszeiten. 301

TOMIO KAKUKAWA

Über den Zusammenhang der Veränderung des Askorbinsäuregehalts mit dem Kohlenhydratgehalt bei den Keimlingen von *Vicia Faba*. 309

No. 4

(Published August 30th, 1943)

NOBORU ABE

The Ecological Observation on *Spirorbis*, Especially on the Post-Larval Development of *Spirorbis argulus* BUSH. 327

SENJI TANITA

Studies on the Calcarea of Japan. 253

JUN NAKAMURA

Diagnostic Characters of Pollen Grains. 491

NOTES ON THE FINGER-LIKE PECTORAL FINS IN THREE JAPANESE FISHES[1]

BY

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(With 6 Text-figures)

(Received September 4, 1941)

In Japan there are found about 10 species of such fishes which possess modified free pectoral fins. Most of them are occupied by the gurnards, and they are generally the bottom fishes. The present paper deals with the histology and the sensibility of the finger-like rays of the pectoral fins using the following three fishes as material, viz., *Lepidotrigla strauchi* STEINDACHNER, *Apistus evolans* JORDAN & STARKS and *Inimicus japonicus* (CUVIER & VALENCIENNES).

The material used in the present investigation was taken from Mutu and Simoda Bay. To make the histological observation, the finger-like rays were fixed in BOUIN's solution. The sections were cut 10 μ thick and were differentiated by the stains of the widest application. In addition these preparations I have also prepared a few series of the same treated with BIELSHOWSKY's Pyridin-silber method (SCHARRER, 1935).

The writer wishes to take this opportunity to express his gratitude to Prof. Dr. SANJI HÔZAWA of the Tôhoku Imperial University, for the kind courtesies and helpful criticisms rendered him during the progress of this work.. The present work was carried out at the Asamushi Marine Biological Laboratory, the Mitsui Institue of Marine Biology and at the Hirosaki High School, and for the facilities they have given the writer he is very grateful.

OBSERVATIONS

1. *Lepidotrigla strauchi* STEINDACHNER

As the finger-like rays of this kind of gurnard are very prominent, they have long attracted the attention of some zoologist. The American species were studied by BATESON (1890), MORRIL (1895), HERRICK (1902, 1907)

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[1] This work was aided by a grant from the Saito Gratitude Foundation.

and others. According to the results given by these authors, the fingers are totally devoid of cutaneous taste buds or other specialized sense organs, and the reaction to food by the fingers is tactile only, without any gustatory elements.

SCHARRER (1935), however, made a careful research of the European species, *Trigla corax*, and concluded that these fingers bear some specialized sense organs which are found among the epidermal cells in their distal parts and moreover they are not sensitive to the tactile stimuli, but are so to the chemical.

I have examined the same problem using the common Japanese gurnard, *Lepidotrigla strauchi*. This fish has three pairs of the fingers as in the case of other gurnards (Fig. 1). The following experiments were made using fifteen fishes of 10-20 cm body length.

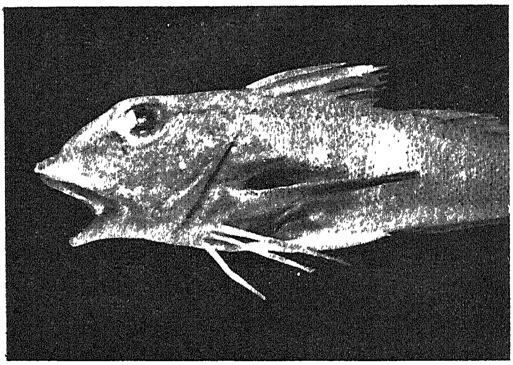

Fig. 1. Side view of the gurnard, showing the fingers. ca. ×1/2

At first, I observed the feeding habits of the normal fishes which were kept in a laboratory aquarium, 70×41 ×36 cm, bottom and three sides of which were made of wood, while the remaining one side was made of glass plate to facilitate the observation. Some amount of sand was spread over the bottom of the aquarium to immitate the natural habitats. The food of this fish, judging from the contents of the digestive canals, seemed to be the small fishes, crustaceans, and lug-worms, etc. When some lug-worms were dropped into the aquarium mentioned above, the fish soon approached and swallowed them using the sight. This fish seems to have intensely keen sight and thus the eyes are used chiefly in securing food. But, it must be kept in mind that this fish under natural conditions usually detects the food hidden in the sandy bottom by the use of its fingers. When the fishes touched the worm hidden in the sand with the fingers, they will stop and will search for it some moments, and then suddenly turn and snap it up. Although this fish has good sight, it is rather a bottom feeder and moves about using its fingers, half walking and half swimming on the bottom of aquarium in order to discover food hidden within. When a wire carrying a wisp of cotton at its hooked end is carefully inserted into the aquarium and is brought near the fish, the fish will touch it with his fingers, but soon it ceases to notice. If, however, the cotton is soaked with the juice prepared from the lug-worm and is used in place of the cotton without any treatment, the fish will touch the cotton first with the fingers and soon will take it into its mouth, although it is ultimately discarded and he gives no further notice after some moments. Moreover, this fish also is seen to give the same response to the cotton soaked with the solution of "Azino-moto", a kind of condiment consisting mainly of gultamic acid compounds.

Next I have taken three sets, each consisting of five, from among fifteen normal fishes already tested, and prepared each set differently by subjecting its members to a special operation.

The fishes of the first set had their fingers cut by means of sharp scissors, but without using any anaesthetization. These fishes thus operated on recovered their activities easily, and seemed to be almost normal. When some worms were given to these fishes, they detected them by using their eyes and pounced upon them in normal fashion. But they failed to recognize the worms hidden within the sand. Such observations were repeated several times obtaining similar results.

The fishes of the second set were made blind applying a hot needle under an anaesthetized condition using 5 percent solution of ether sea water. Two days after such an operation, they were observed to swim in the normal way feeling the bottom with their fingers, although they occasinally collided with the walls of the aquarium. If the lug-worms were dropped into the aquarium which contained five operated fishes, it was noticed that they were able to detect the worms by feeling the bottom with their fingers when the worms fell upon the bottom of the aquarium. But they were unable to pounce upon the worms as they fell from above.

Of the fishes of the third set, to determine the sinsibility of the finger, the eyes and olfactory organs were made functionless by performing operations to destroy the eyes by using a hot needle, and to cut the olfactory nerves by making an incision in a spot just posterior to the olfactory pits. After the expiration of a week, they were carefully tested. The fishes swam about trailing the bottom with their fingers and detected the meat as the normal ones did. Therefore, it seems quite clear that this fish can detect its food laid on the bottom by using the fingers alone, and this ability is not hindered even when the olfactory organs and eyes were made functionless. When a fine glass rod of some 2 cc diameter was carefully inserted into the aquarium and was brought to the tip of the fingers of an operated fish, the fish gave no remarkable responses to this rod. Similar reactions were also observed when a small wooden or metalic rod was used in place of the glass rod. If the tips of the fingers were stimulated violently by these rods, the fishes moved away.

Next, I endeavored to ascertain the effect of some chemical stimuli by using a fine-pointed pipette, and pouring a jet of various solutions tinged with methylen blue to the fingers, in such a manner as was mentioned in the writer's previous report (Satô, 1938). At first the fishes were tested with distilled water, but they either merely ignored or avoided it. When 10–50 percent solution of saccharose and sodium chloride were applied, they showed a slight interest in it, but occasionally avoided it. On applying 10 percent of acetic acid, no remarkable reaction was observed. Even when the 20–40 percent solution of acetic acid was used, these fishes showed only slight response to it. If, however, they were tested with a more concentrated solution of 50 percent of the same acid, they showed a distinct response, viz., they usually turned away from it or they buried their pectoral fins together with the lower parts of their body in the sand. These experiments were repeated several times with similar results. On applying a solution filtered from a mixture of freshly chopped lug-worms and tap-water, they usually reacted in the same way as they did to the meat and began to systematically search the bottom with their fingers. This kind of response was more striking when the more concentrated solution was used. This fish gave a similar reaction to the solution of the solution of the condiment, "Azino-moto". Here, it is interesting to note that this fish shows a remarkable reaction only when the various kinds of solutions are poured upon the tips of the fingers, but the fish does not readily show any excitment when the solutions are applied to the basal parts of the same.

Now turnning to the histological structure of this finger, the writer quite agrees with SCARRER (1935) in the opinion that some special sense cells are found among the epidermal cells of the fingers in this gurnard (Fig. 2) and that these sense cells limit their distribution to the tip of the fingers. The sense cells are spindle shaped and are larger in size than the other epidermal cells. In structure, the sense cell does not exhibit any remarkable deviation from that of *Trigla corax* which was fully described by SCHARRER, so the writer will dispense with the note concerning it. This sense cell responds to a stimulation caused by some substances contained in the solution and which emanated from the food.

These results seems to indicate that the fingers are more sensitive to a chemical stimuli than to the tactile. Accordingly, the finger may act as a chemoreceptor which is serviceable in sensing food. This finger also seems to bear a considerable to the barbels of the goat-fishes and of the others (SATÔ, 1937 a, b, c and 1938) in sensibility and function. This kind of gurnard, judging from these results, undoubtedly finds its food, consisting mainly of the annelids, chiefly with its fingers even in natural habitat as observed in the aquarium.

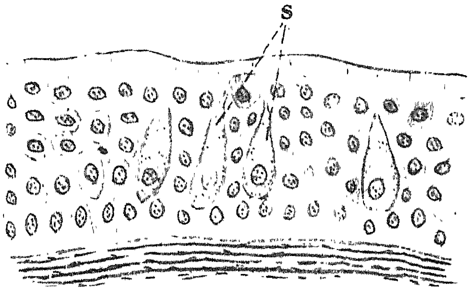

Fig. 2. Epidermis located in the distal portion of the finger of the gurnard. ×400. s. sense cells

2. *Apistus evolans* JORDAN & STARKS

The present fish lives in the muddy bottom near the seashore in the southern parts of Japan. It has one pair of the finger-like pectoral fins which are longer and more slender than those of the gurnard (Fig. 3). At first, I observed the feeding habits of this fish in the observatory aquarium. This fish remains quitely on the sandy bottom most of day-time and it is often found with the lower parts of the body buried in the sand. Occasionally it swimms close the bottom surface, moving the fingers in a similar manner as that of the gurnard, but the writer did not succeed in finding the fish feeding with the fingers. Taking into concideration that this finger might be used by the fish in discovering food buried in the sand, the writer made some trials, but I could not determine whether or not this fish detects the hidden food by using its fingers. Under some constricted conditions, this fish detects its food mainly with its eyes and pounces upon the food lying close to the bottom.

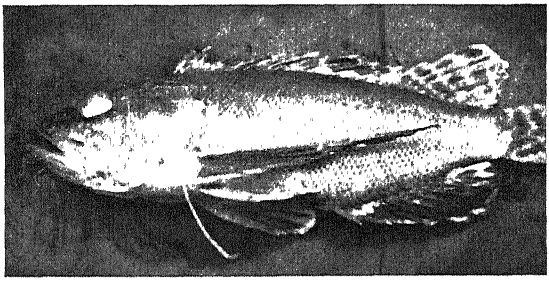

Fig. 3. Side view of *Apistus evolans*, showing the finger. ca ×1/2

Next, these fishes were operated upon with the same methods as in the case of the gurnard and were tested with the same experiments. The fishes which suffered from such treatment did not give any response to the chemical stimulations. On applying the various solutions treated by the same method as in the case of the gurnard, no remarkable responses were observed. But, they showed often a nervous disposition on slight provocation.

The fingers of this fish seems to be slightly sensible to the chemical stimulations and might not be useful in recognizing the food hidden in the sand, in other words, the fingers are probably not so important in performing its daily activity as in the case of the gurnard. This conclusion seems to be also supported by the microscopical examination made on the structure of the finger. The special sense cells, as far as the writer was able to determine, are not found in the epidermis of this finger (Fig. 4). The epidermis is composed of the oval shaped epidermal cells alone and no specialized sense cells are discernible from the other oridinary epidemal cells, although this point needs further careful investigation.

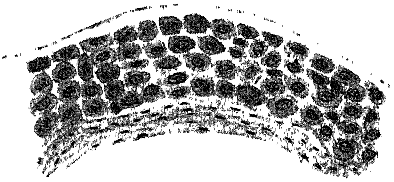

Fig. 4. Epidermis found in the distal portion of the finger of *Apistus evolans*. ×320

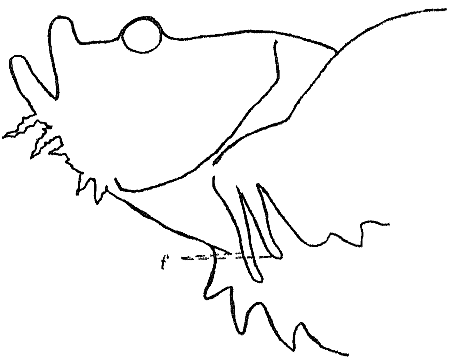

Fig. 5. Side view of *Inimicus japonicus*, showing diagramatically the fingers, f.

3. *Inimicus japonicus* (CUVIER & VALENCIENNES)

This fish bears two pairs of the finger-like rays which are not so prominent as in the case of the gurnard (Fig. 5). It never swimms in the aquarium unless it is disturbed violently by using a wooden or glass rod. Most of the day-time this fish lies still with its mouth closed or nearly so. The respiratory rate is rather low, being about 22 per minute in water of 11°C.

Judging from the contents of the digestive canals, the normal food of this species seems to be small fishes, young shrimps and the small crustaceans, etc.

This fish, however, never takes food in the aquarium and thus the writer was not able to get evidence that it detects the presense of food by trailing its fingers, but it may be quite possible that the fingers may not be useful in searching for food, because it never trails the food with its fingers.

The writer has examined the sensibility of this finger using the fish operated upon by the same method as in the case of the gurnard. Now using a fine pipette a number of jets of various solutions were poured on the tip of the fingers, but this did not get any responses from them and if the jet was too strong, the fish moved away. Even when the extract of crab was ayplied in the same way, this fish gave no remarkable responses. The writer has watched this fish repeatedly, but it was never seen that this fish reacted to the extract made from the crab. This would seem to indicate that this finger is not sensible to chemical stimulation which emanates from food. Moreover, this finger is totally deprived of any specialized sense cells in its epidermis. On examining sections, one notices that most of the epidermal cells are cornified, excepting those found in the small area which is occupied by the basal cells. The cornified area takes a strong plasma stain in sharp contrast to the underlaying cells and is stained very strongly with eosin or picric acid. These cornified cells are entirely destitute of nucleus (Fig. 6).

From these results, I am inclined to think that the fingers of this kind of fish seems to have little value in recognizing food, namely, they may not be functional as a chemoreceptor and are not serviceable in securing food, but may act as a creeping organ.

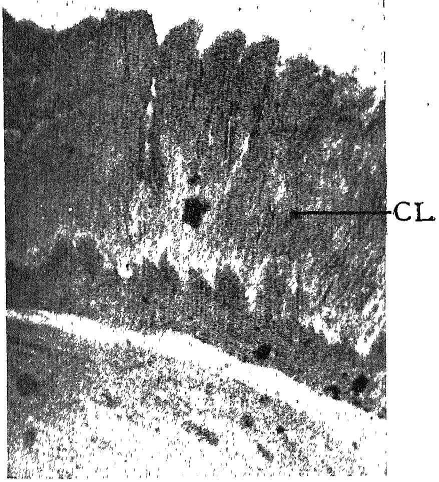

Fig. 6. Epidermis located in the distal portion of the finger of *Inimicus japonicus.* ×70. CL. cornified layer.

SUMMARY

In the present paper, the wtiter has examined the structure and sensibility of the finger-like rays of the pectoral fins using three kinds of Japanese fishes as material. The results thus far obtained may be summarized as follows:

1. The finger-like structure fonnd in the Japanese gurnard, *Lepidotrigla strauchi*, bears the specialized sense cells among the epidermal cells located in its distal parts. These sense cells are spindle in shape and respond to a chemical stimulation caused by the substances in solution and which emanate from meat.

The fingers, therefore, seems to be very necessary in recognizing the food buried in the sand, and this ability is not hindered by making the olfactory organs and eyes functionless.

2. *Apistus evolans* has one pair of fingers bearing some resemblance to that of the gurnard in external appearance. It is suggested that the fingers may be used for the same purpose as in the case of the gurnard; but though the writer repeatedly watched, it was never seen that this fish recognized the hidden food by using its fingers. The fingers, as far as I could determine, are deprived of the specialized sense cells to be found among its epidermis.

3. *Inimicus japonicus* bears two pairs of fingers which are deprived entirely of the special sense cells among their epidermis. Most parts of the epidermis are composed of the cornified cells. Thus, the absence of the special sense cells seems to bring about the loss of the ability to find hidden food.

REFERENCES

BATESON, W., 1890. The sense organs and preceptions of fishes with remarks on the supply of bait. Jour. Mar. Biol. Asso., Vol. I. n. s. pp. 225–256.

HERRICK, C. J., 1902. The organ and sense of taste in fishes. Bull. U. S. Commiss., Vol. 22. pp. 237–272.

——, 1907. The tactile centers in the spinal cord and brain of the sea robin *Prinotus carolinus* L. Jour. Comp. Neurol., Vol. 17. pp. 307–327.

MORRILL, A. D., 1895. The pectoral appendages of Prinotus and their innervation. Jour. Morph. and Physiol., Vol. II. pp. 177–192.

SATÔ, M., 1937 a. Preliminary report on the barbels of a Japanses goatfish, *Upeneoides bensasi* (T. & S.). Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. II. no. 3. pp. 259–264.

——, 1937 b. Further studies on the barbels of a Japanese goatfish, *Upeneoides bensasi* (T. & S.). Ibid., Vol. II. no. 3. pp. 297–302.

——, 1937 c. On the barbels of a Japanese sea catfish, *Plotosus anguillaris* (LACÉPÈDE). Ibid., Vol. II. no. 3. pp. 323–332.

——, 1938. The sensibility of the barbel of *Upeneus Spilurus* BLEEKER, with some notes on the schooling. Ibid., Vol. 12. no. 4. pp. 489–500.

SCHARRER, E., 1935. Die Empfindlichkeit der freien Flossenstrahlen des Knurrhahns (Trigla) für Chemische Reitze. Zeit. vergl. Phpsiol. Bd. 22. S. 145–154.

FURTHER STUDIES ON THE EMBRYOGENY OF *TORREYA*[*]

BY

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(With Pl. I and 9 Text-figures)

(Received September 29, 1941)

Last year (1940) the present writer published a paper on the embryogeny of *Torreya nucifera* in the November number of our 'Science Reports of Tôhoku Imperial University'. In the next month, however, BUCHHOLZ's paper entitled 'The embryogeny of *Torreya*, with a note on *Austrotaxus*' appeared in the Bulletin of Torrey Botanical Club (Vol. 67, No. 9 December, 1940). In this paper he described the embryogeny of three species of *Torreya*, namely *T. nucifera*, *T. taxifolia* and *T. californica*. But his description concerning the embryogeny of *T. nucifera* in some points decidedly differs from that of the present author. For example BUCHHOLZ states that the first cell-wall formation in the proembryo occurs in the four nucleate stage, whilst the present writer insists on the cell-wall formation in the eight nucleate stage. To offer a conclusive evidence, a photograph showing the third mitosis in the proembryo in the writer's material of last year is presented as text-fig. 1 of this paper. Under these circumstances it has now become important to know whether BUCHHOLZ and the writer made the investigations on plants belonging to the same species or not. Last year the writer collected the material mainly from a tree in a village near Ninomiya, Kanagawa Prefecture. This plant (fig. 2) has the appearance of a typical

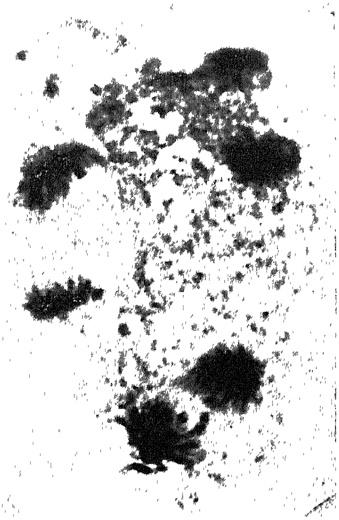

Fig. 1. Third mitosis in the plant A. ×1040

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[*] The cost of this research has been defrayed from the Scientific Research Expenditure of the Department of Education.

Torreya nucifera. The seeds were estimated to be, in the mean, 23 mm long and 20 mm broad. And the female gametophyte is 635 μ long and 432 μ broad.

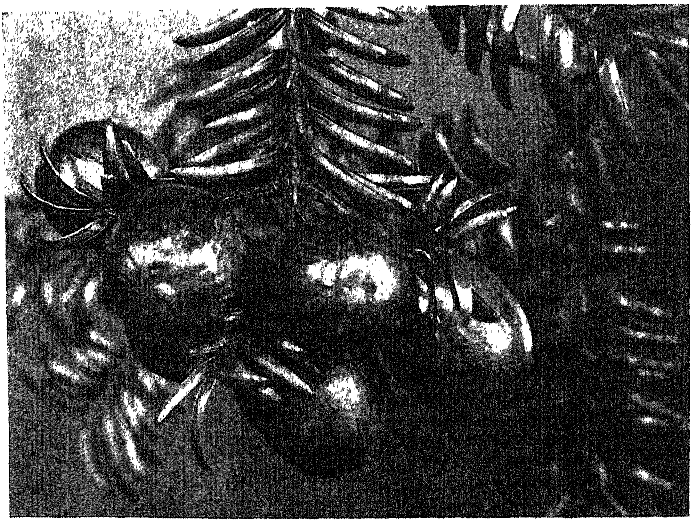

Fig. 2. Plant A. ×0.9

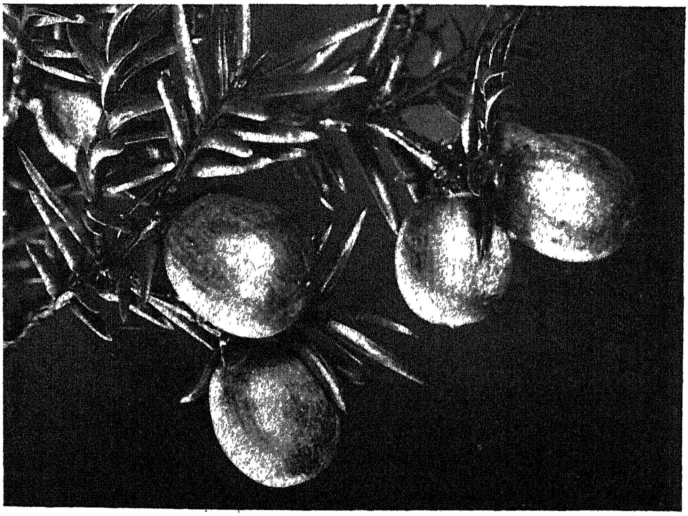

Fig. 3. Plant B. ×0.9

This year the material was obtained from a tree in Sendai. For the sake of convenience this plant will be called B and the plant from which last year the material was collected will be treated under the name A.

The results obtained from the plant B will be described below.

The plant B is a tree standing in a garden of a temple in Sendai. The general appearance of a branch of this plant is shown in fig. 3. The seeds at maturity measure 21 mm long and 18 mm broad, somewhat smaller than those of the plant A. But about the beginning of July, in sharp contrast to typical plants of *Torreya nucifera*, the seeds of this plant are very small and look as if they had remained sterile.

In the year 1928 T. Doi and K. Morikawa established a species of *Torreya* under the name *Torreya igaensis*. According to their descriptions the seeds of this plant are still smaller than the present ones; they are 18–21 mm long, 10–15 mm broad. This species is not seen in the vicinity of Sendai.

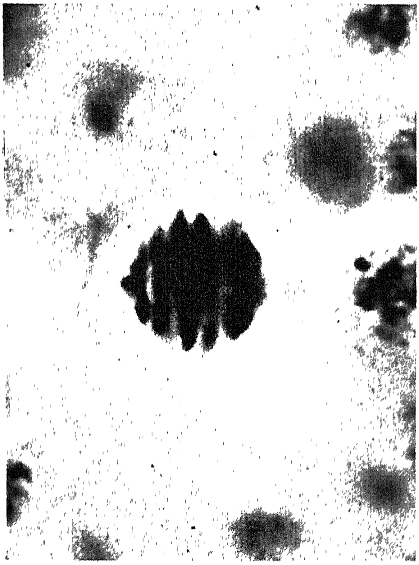

Fig. 4. First division of the meiosis of a macrospore mother cell of the plant B. ×1500

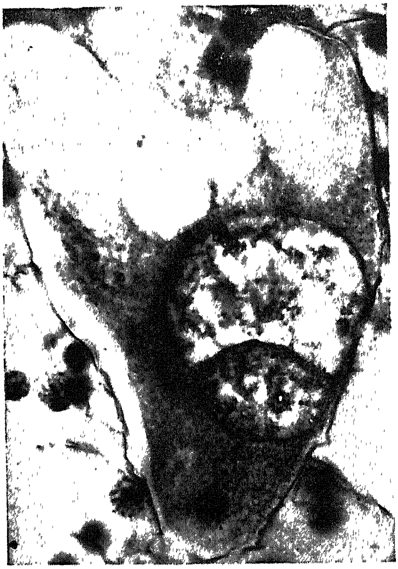

Fig. 5. Fertilization in the plant B. ×600

The meiotic division in the macrospore mother cell of the plant B occurred this year at the end of May (fig. 4) and fertilization in later August (fig. 5). Just before the time of fertilization, one functional sperm nucleus together with an abortive sperm nucleus, a tube nucleus and a stalk nucleus embedded in their own dense cytoplasma are discharged into the archegonium; the latter two nuclei, however, soon become disorganized (fig. 6), The size of the female gametophyte at the time of fertilization is 405 $\mu \times 446 \mu$ and the size of the archegonium in the same stage is

$72\mu \times 141\mu$. Although BUCHHOLZ could not ascertain the presense of the ventral canal nucleus in his plants, it was not difficult to see its real existence in our plant.

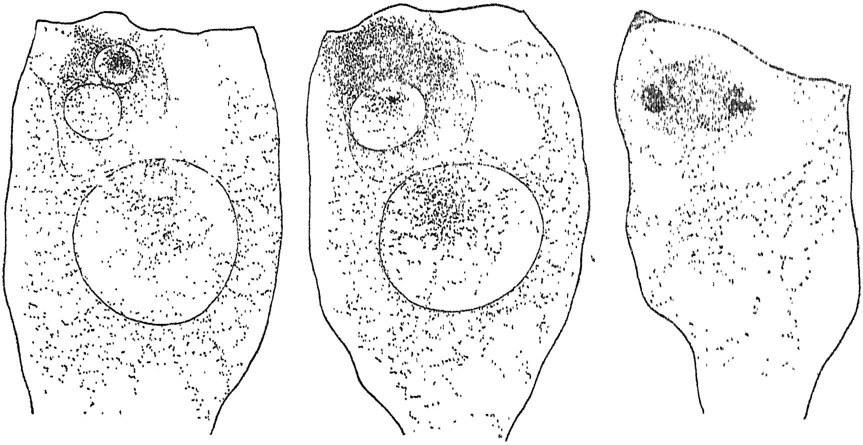

Fig. 6. Three successive sections of an archegonium just before the fertilization. A functional sperm nucleus, an abortive sperm nucleus, a stalk nucleus and a tube nucleus are seen above the egg nucleus. (Plant B.) ×470

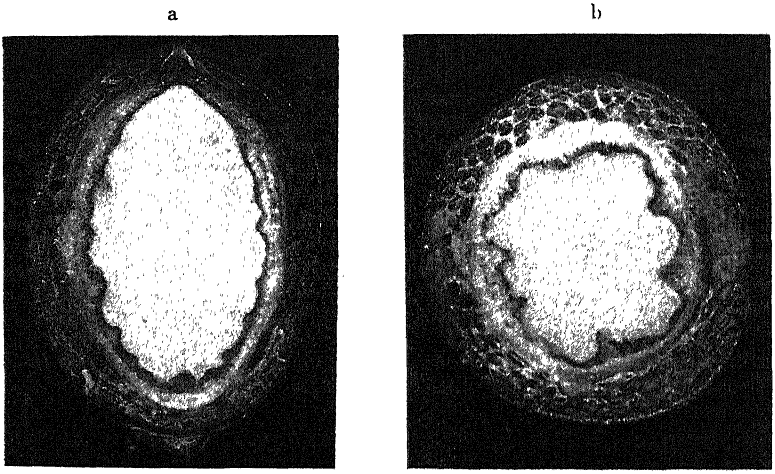

Fig. 7. a, Seed of the plant B in a median longitudinal section. b, The same in a cross section. ×2.7

As to the shape of the endosperm, BUCHHOLZ says: "There are usually three principal sinuses which extend less than half way inward from the margins to the center and there are many minor corrugations." The cross and longitudinal sections of the seeds of the plant B are shown in fig. 7.

The sinuses are quite irregular, showing no principal ones. As to the shape of the endosperm there is no distinct difference between the plants A and B.

In the plant B, the egg nucleus soon after fertilization performs the first mitosis. The resulting two nuclei descend to the bottom of the archegonium; they are arranged there right and left or above and below. The four nucleus stage comes next and the first cell-wall formation occurs generally in this stage (Pl. I. fig. 5, 6).

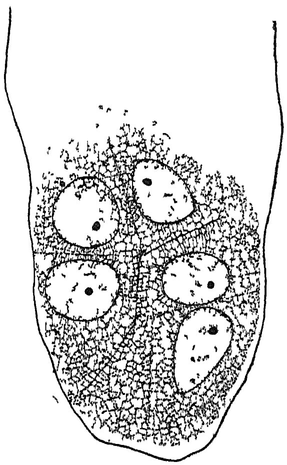

Fig. 8. Cell-wall formation in 8-nucleate stage in the plant B. ×470

But the occurrence of the first cell-wall formation in the eight nucleate stage was found three times in the material collected on August 27th (fig. 8). It may be worthy of mention that the majority of the proembryos in this material were, however, already in far more advanced stages. The cells in the 4-cell stage are arranged in two tiers; the cells in the upper tier, 2 or 3 in number, have no wall towards the centre of the archegonium. By the subsequent division which takes place synchronously in the upper tier but independently in the lower tier, the numbers of the cells of both tiers are augmented. The cells of the lower tier are arranged irregularly in two or three layers, while the cells of the upper tier, usually four or six in number, are arranged in one layer and are all open towards the centre of the archegonium, as in the preceeding stage. In the next division in the upper layer the mitotic spindles are directed parallel to the long axis of the archegonium (Pl. I. fig. 8). As is usual in most conifers, the prosuspensor and the rosette nuclei are definitely differentiated by this division (Pl. I. fig. 9). Later the rosette nuclei become disintegrated and thick wall is formed at the upper boundary of the prosuspensor, as in *Podocarpus* (fig. 9). BUCHHOLZ's description concerning the course of development succeeding the four nucleate stage is rather simple and it is not clear whether his plants are identical in development with the plant B or not.

Anyhow, in writer's opinion the plants A and B seem to belong to different species. In all probability the plant B may be a variety of *Torreya igaensis* DOI et MORIKAWA.

In conclusion, *Torreya* in Japan is divided into at least two groups.

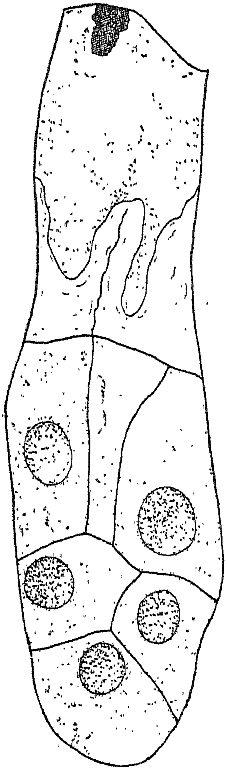

Fig. 9. Proembryo of the plant B. Prosuspensor is slightly elongated. Thick wall is formed at the upper boundary of the prosuspensor. ×470

These two groups are different not only in their external characters, especially in the size of the seeds, but also in the mode of the proembryo formation. Namely, one of the two performs the first cell-wall formation in the four nucleate stage and the other in the eight nucleate stage. The latter ought to be considered naturally as a more primitive one. BUCHHOLZ's plant and the plant B belong to the first and the plant A to the second group. In each of these two groups two or more species or varieties may exist. Probably *Torreya igaensis* DOI et MORIKAWA is the typical representative of the first and *T. nucifera* S. et Z. the typical representative of the second group.

SUMMARY

1. In the present investigation the material was collected from a tree in Sendai. For the sake of convenience the writer named this plant B, and the plant from which last year the material was obtained, A. The plant A is considered to be a typical *Torreya nucifera*. The seeds of the plant B are somewhat smaller than those of the plant A and ripen later.

2. In the plant B; the first cell-wall formation generally occurs in the four nucleate stage. The four cells are arranged in two tiers. By the subsequent divisions the numbers of the cells in both tiers are augmented. But all the cells in the upper tier are arranged in one layer. The mitotic spindles of the next division in the upper tier are directed parallel to the long axis of the archegonium and by this division the prosuspensor and the rosette nuclei are definitely differentiated.

3. The occurrence of the first cell-wall formation in the eight nucleate stage is sometimes found also in the plant B, especially in the ovules retarded in their development.

4. The plant B seems to be a variety of *Torreya igaensis* DOI et MORIKAWA.

LITERATURE

BUCHHOLZ, J. H.. 1940. The Embryogeny of *Torreya*, with a Note on *Austrotaxus*. Bull. of the Torrey Bot. Club. Vol. 67.

COULTER, J. M. and LAND, W. J. G., 1905. Gametophyte and Embryo of *Torreya taxifolia*. Bot. Gaz. 39.

MORIKAWA, K., 1938. *Torreya igaensis*, a new species of the Genus *Torreya* and *Torreya macrosperma*. Bot. Mag. Tokyo. Vol. 42. pp. 533–536.

ROBERTSON, A., 1940. Studies in the Morphology of *Torreya californica* Torrey. New Phyt. 3.

TAHARA, M., 1940. Embryogeny of *Torreya nucifera* S. et Z. Sci. Rep. Tôhoku Imp. Univ. 15.

EXPLANATION OF PL. I.

Fig. 1. Fusion nucleus.
Fig. 2. 2-nucleate stage.
Fig. 3. The same. Two nuclei at the bottom of the archegonium.
Fig. 4. 4-nucleate stage.
Fig. 5 and 6. First cell-wall formation in the 4-nucleate stage.
Fig. 7. Subsequent stage.
Fig. 8. Nuclei in the upper tier in the metaphase of a mitosis.
Fig. 9. Proembryo nearly completed its development.

(Magnification: ×470.)

Sci. Rep., Tôhoku Imp. Univ., Ser. IV, Vol. XVII, Pl. I.

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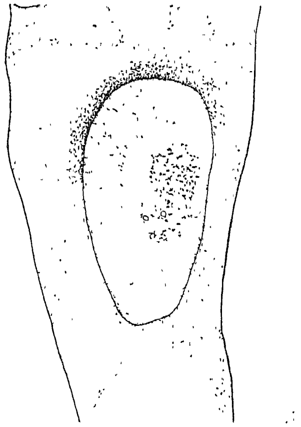

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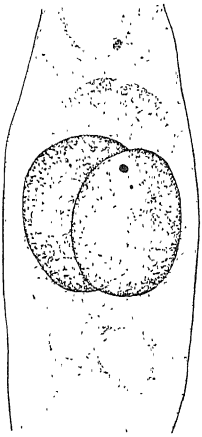

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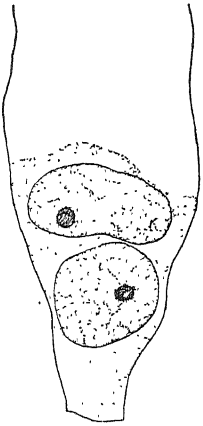

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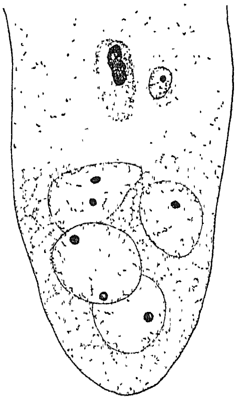

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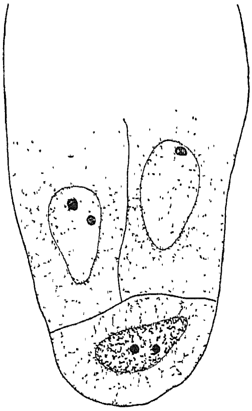

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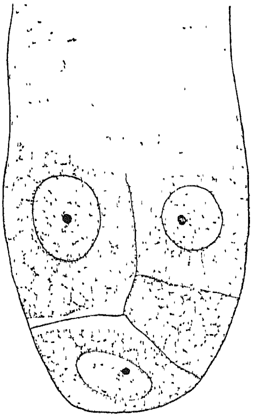

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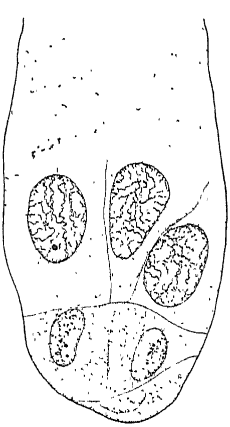

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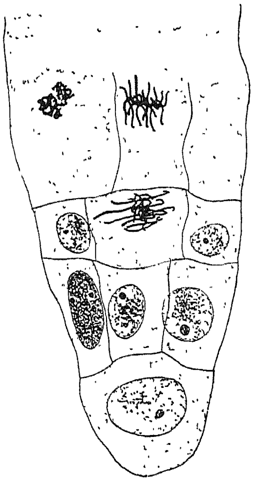

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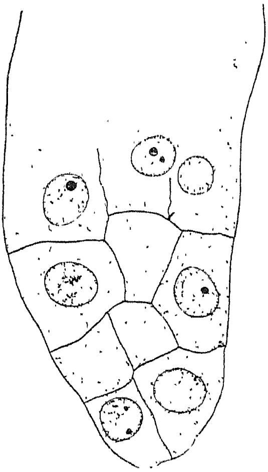


M. Tahara: Embryogeny of *Torreya*

CALCAREOUS SPONGES COLLECTED IN THE KANTÔ DISTRICT, JAPAN

BY

SENJI TANITA

Biological Institute, Tôhoku Imperial University, Sendai, Japan

(With Plates II–IV and 13 Text-figures)

(Received October 20, 1941)

CONTENTS

Introduction 18

Description of the Species 20

I. Family Homocoelidae

1. Leucosolenia coriacea (MONTAGU) 20
2. Leucosolenia gardineri DENDY 21
3. Leucosolenia izuensis, n. sp. 21
4. Leucosolenia laxa KIRK 23
5. Leucosolenia mutsu HÔZAWA 23
6. Leucosolenia protogenes (HAECKEL) 24
7. Leucosolenia serica, n. sp. 25
8. Leucosolenia stipitata DENDY 26
9. Leucosolenia tenera TANITA 27
10. Leucosolenia wilsoni DENDY 27

II. Family Sycettidae

11. Sycon album, n. sp. 28
12. Sycon cylindricum, n. sp. 30
13. Sycon luteolum, n. sp. 32
14. Sycon matsushimense TANITA 35
15. Sycon misakiensis HÔZAWA 35
16. Sycon rotundum TANITA 36

III. Family Heteropiidae

17. Grantessa intusarticulata (CARTER) 36
18. Grantessa mitsukurii HÔZAWA 37
19. Grantessa parva, n. sp. 38
20. Grantessa shimeji HÔZAWA 40
21. Grantessa shimoda, n. sp. 40
22. Heteropia striata HÔZAWA 43
23. Amphiute ijimai HÔZAWA 44
24. Vosmaeropsis japonica HÔZAWA 44
25. Vosmaeropsis maculata HÔZAWA 45

IV. Family Grantiidae
26. Ute pedunculata Hôzawa 45
27. Leucandra abratsbo Hôzawa 46
28. Leucandra dura Hôzawa 47
29. Leucandra foliata Hôzawa 47
30. Leucandra hozawai, n. sp. 48
31. Leucandra impigra, n. sp. 50
32. Leucandra magna, n. sp. 53
33. Leucandra mitsukurii Hôzawa 55
34. Leucandra multituba Hôzawa 55
35. Leucandra nakamurai, n. sp. 56
36. Leucandra pacifica Hôzawa 58
37. Leucandra sola, n. sp. 59
38. Leucandra tuberculata Hôzawa 61
39. Leucandra valida Lambe 62
V. Family Amphoriscidae
40. Leucilla hirsuta, n. sp. 62
Literature Cited 65
Explanation of the Plates 68

INTRODUCTION

Thirty-nine species of calcareous sponges have been hitherto reported from the Kantô District of Japan by such authors as Haeckel, Döderlein, Hara, and Hôzawa. Haeckel has described in his monograph on calcareous sponges four species which were collected by Gildemeister in Jeddo (Tokyo Bay). In 1894 Hara reported on a new calcarea, *Lelapia nipponica*, using a single specimen obtained from the Sagami Sea. Döderlein secured an interesting specimen of calcareous sponge off Enoshima in the Sagami Sea and recorded it in 1892 under the name of *Petrostroma schulzei*. In 1916 and 1929, Hôzawa described 34 species of calcareous sponges from the Kantô District, obtaining the specimens from various parts of the Sagami Sea and of Suruga Bay.

The following is the list of the species which were reported by the above mentioned investigators and the localities where the specimens were obtained.

	Species	Localities
1.	*Leucosolenia amitsbo* Hôzawa	Sagami Sea
2.	*Leucosolenia blanca* (Michlucho-Maclay)	Doketsba, Sagami Sea
3.	*Leucosolenia japonica* (Haeckel)	Coast of Japan (Jeddo)
4.	*Leucosolenia sagamiana* Hôzawa	Off Odawara, Sagami Sea
5.	*Dendya quadripodifera* Hôzawa	Off Ohshima, Sagami Sea
6.	*Petrostroma schulzei* Döderlein	Off Enoshima, Sagami Sea
7.	*Sycon calcar-avis* Hôzawa	Off Odawara, Sagami Sea

8. *Sycon digitiformis* HÔZAWA ....Sagami Sea
9. *Sycon misakiensis* HÔZAWA ....Misaki, Sagami Sea
10. *Sycon okadai* HÔZAWA ....Misaki, Sagami Sea
11. *Sycon raphanus* O. SCHMIDT ....Jeddo (Tokyo Bay)
12. *Sycon yatsui* HÔZAWA....................................Misaki, Sagami Sea

13. *Grantessa basipapillata* HÔZAWA ....Doketsba, Sagami Sea
14. *Grantessa intusarticulata* (CARTER) ....Misaki & Dôketsba, Sagami Sea
15. *Grantessa mitsukurii* HÔZAWA ....Koajiro, Sagami Sea
16. *Grantessa sagamiana* HÔZAWA ....Okinose, Sunosaki, Enoura
17. *Grantessa shimeji* HÔZAWA ....Misaki, Sagami Sea

18. *Heteropia striata* HÔZAWA ....Koajiro & Abratsbo, Sagami Sea

19. *Amphiute ijimai* HÔZAWA ....Doketsba, Senoura in Suruga Bay

20. *Vosmaeropsis japonica* HÔZAWA ....Misaki, Sagami Sea
21. *Vosmaeropsis maculata* HÔZAWA...............Misaki; Enoura in Suruga Bay

22. *Grantia cupla* (HAECKEL) ....Jeddo (Tokyo Bay)

23. *Ute armata* HÔZAWA ....Sagami Sea
24. *Ute pedunculata* HÔZAWA.......................................Sagami Sea

25. *Leucandra abratsbo* HÔZAWA ....Abratsbo, Sagami Sea
26. *Leucandra dura* HÔZAWA ....Misaki, Sagami Sea
27. *Leucandra foliata* HÔZAWA ....Niijima; Doketsba; Okinose
28. *Leucandra mitsukurii* HÔZAWA ....Misaki, Sagami Sea
29. *Leucandra multituba* HÔZAWA ....Misaki, Sagami Sea
30. *Leucandra odawarensis* HÔZAWA ....Off Odawara, Sagami Sea
31. *Leucandra okinoseana* HÔZAWA ....Okinose, Sagami Sea
32. *Leucandra onigaseana* HÔZAWA ....Onigase; off Niijima
33. *Leucandra pacifica* HÔZAWA ....Doketsba, Sagami Sea
34. *Leucandra paucispina* HÔZAWA ....Okinose, Sagami Sea
35. *Leucandra sagamiana* HÔZAWA ....Off Odawara, Sagami Sea
36. *Leucandra solida* HÔZAWA.................................Misaki, Sagami Sea
37. *Leucandra tuberculata* HÔZAWA ....Koajiro, Sagami Sea

38. *Leucyssa spongilla* HAECKEL ....Jeddo (Tokyo Bay)

39. *Lelapia nipponica* HARA ....Doketsba, Sagami Sea

During the years extending from 1926 to 1940, many specimens of calcareous sponges have been collected at various parts of the same District by Professor S. HÔZAWA, by Professor Y. OKADA, by Dr. M. ERI, and by the present writer.

The localities of the calcareous sponges which formed the material for the writer's present paper are as follows: in Chiba Prefecture — Awa-Kominato, Sunosaki, Tateyama, and Daibusa; in Kanagawa Prefecture — Misaki, Kamakura, Enoshima, Futamachiya, Yodomi, and Zyôgashima; in Shizuoka Prefecture — Susaki, Shimoda Bay, Nabeta, and Mikomoto-jima.

The number of species treated in the present paper is 40, and they belong to 9 genera and 5 families. Of these 40 species, 3 are reported for the first time from Japanese waters and 11 are new to science. Most of the specimens which were collected by Professor HÔZAWA and by the writer are now deposited in the Museum of the Biological Institute of the Tôhoku Imperial University.

Before going further the writer wishes to acknowledge his indebtedness to some institutions and persons for their support given to the present work. The writer's gratitude is first paid to Professor Dr. SANJI HÔZAWA of the Tôhoku Imperial University for his kind guidance and the valuable advice rendered to the writer during the course of the present investigation. The writer also wishes to express his thanks to Professor Dr. YAICHIRO OKADA of the Tokyo Higher Normal School, to Assistant Professor Dr. ISAO MOTOMURA of the Tôhoku Imperial University, and to Assistant Professor MEGUMI ERI of the Tokyo Imperial University. These gentlemen have kindly placed their materials at my disposal for study. Furthermore I express my gratitude to Mr. TAKANAGA MITSUI, the founder of the Mitsui Institute of Marine Biology, and to the late Dr. SHÛYA NAKAMURA of the Kominato Marine Biological Station, for their help shown in various ways during my stay at the Mitsui Institute and at the Kominato Biological Station.

DESCRIPTION OF THE SPECIES

I. Family **Homocoelidae** DENDY

Genus **Leucosolenia** BOWERBANK

1. **Leucosolenia coriacea** (MONTAGU)

Spongia coriacea. MONTAGU, 1812, p. 116.

Grantia coriacea, JOHNSTON, 1842, p. 183, Pl. XXI., fig. 9.

Leucosolenia coriacea, BOWERBANK, 1864, Vol. II., p. 34; GRAY, 1867, p. 556; CARTER, 1877, p. 42; HANITSCH, 1895, p. 206; BREITFUSS, 1897, p. 211; 1898, p. 12; 1898, p. 20; 1898, p. 91; 1927, p. 28; 1932, p. 241; 1936, p. 6; DENDY, 1905, p. 226, Pl. XIII., fig. 8; DENDY and ROW, 1913, p. 725; HERNANDEZ, 1918, p. 9; ROW and HÔZAWA, 1931, p. 735; BURTON and RAO, 1932, p. 303; BURTON, 1933, p. 233; TOPSENT, 1936, p. 2, figs. 1, 2.

Clathrina sulphurea, CARTER, 1871, p. 279.

Clathrina coriacea, RIDLEY, 1881, p. 132; MINCHIN, 1896, p. 359.

Ascetta coriacea, HAECKEL, 1872, Bd. II., p. 24, Taf. 3, Taf. 5, fig. 2; HANITSCH, 1890, p, 232; ARNESEN, 1901, p. 10.

Several small specimens have been assigned to this well-known species.

They were obtained by the writer from two different localities, one in Bôsyû Sunosaki and the other in the neighbourhood of the Misaki Marine Biological Station. Each of these specimens represents a loose mass, composed of slender anastomosing Ascon-tubes, attached to the lower parts of sea-weed. The colour in alcohol is greyish-white being covered by mud.

Previously known Distributions:—Cosmopolitan: Arctic Ocean; Atlantic Coast of Europe; Mediterranean Sea; Pacific Ocean; Indian Ocean; West Australia.

Localities:—Bôsyû Sunosaki; Misaki.

Remarks:—This species was first described by MONTAGU in 1812, the name being *Spongia coriacea.* Since that time it has been reported by many writers as found in various localities of the world. This species, therefore, seems to be rather common, being met with especially often in Europe. However, until now, it has not been found in Japanese waters, this forming the first record. Judging from the distributions above mentioned, the present species will be discovered in various parts of the coast of Japan in the future, when the survey has been done more fully.

2. Leucosolenia gardineri DENDY

Leucosolenia gardineri, DENDY, 1913, p. 2. Pl. I., figs. 1, 2, Pl. III., figs. 1-3; HÔZAWA, 1940, p. 35.

Seven specimens of this species were collected by the writer from the shore of Awa-Kominato. The sponges at hand differ considerably from the other specimens both in shape and size, each showing a more or less flattened colony, attached to the substratum directly. The Ascon-tubes are very slender and form a very closely-meshed reticulation. The surface of the sponge appears closely and minutely punctated from the presence of numerous pseudopores.

Previously known Distributions:—Chago Archipelago (DENDY); Noto Wajima (HÔZAWA).

Locality:—Awa-Kominato.

3. Leucosolenia izuensis, n. sp.

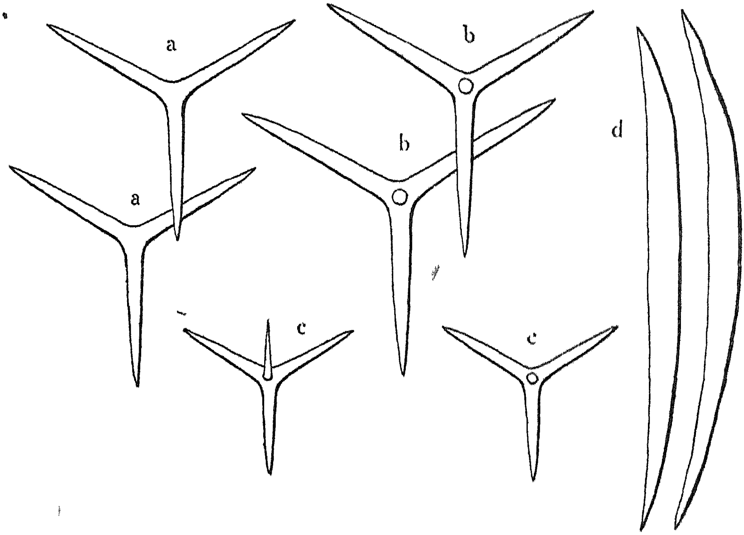
(Pl. II, fig. 1; Text-fig. 1)

There is a single specimen (Pl. II, fig. 1) of this new species in the collection. It was collected by the writer in the neighbourhood of the Mitsui Institute of Marine Biology, near Shimoda, in 1939.

The sponge consists of loosely branched and anastomosing Ascon-tubes directly attached to a substratum. There is no pseudoderm covering the whole colony and no endogastric network. The sponge is rather small and attains a length of about 6 mm. The diameter of the Ascon-tubes varies from 0.3 mm to 1 mm and the dermal surface of the tubes has a hispid appearance on account of projecting oxea.

The colour of the sponge is yellowish-white when preserved in alcohol.

Structure:—The skeleton of the sponge is composed of triradiates, large and small quadriradiates, and oxea. The tri- and quadriradiates are arranged in a few layers in the sponge wall. The quadriradiates are more numerous than the triradiates and their apical rays project into the gastral cavity. The larger quadriradiates are usually arranged in the dermal skeleton. The oxea occur vertically or obliquely to the surface of the Ascon-tubes.



Text-fig. 1. *Leucosolenia izuensis*, n. sp. a, triradiates of Ascon-tube; b, large quadriradiates of Ascon-tube; c, small quadriradiates of Ascon-tube; d, oxea. (all ×150)

Spicules (Text-fig. 1):—Triradiates (a) are regular, rays straight, rather sharply pointed, 85–120 μ long and 8–14 μ thick at base.

Large quadriradiates (b) also regular. Facial rays slightly larger than triradiates above mentioned, straight, 120–165 μ long and 14–18 μ thick at base. Apical ray also straight, fairly sharply pointed, slightly longer and thinner than facial rays, 140–190 μ long and 10–14 μ thick at base.

Small quadriradiates (c) resemble the large ones, except for their size. Facial rays are 60–95 μ long and 8–10 μ thick at base. Apical ray is 70–100 μ long and 6–8 μ thick at base.

Oxea (d) elongate spindle-shaped, slightly curved, sharply pointed at both ends, 270–550 μ long and 17–30 μ thick at the broadest parts.

Locality:— Susaki, near Shimoda.

Remarks:— This species appears to be more closely allied to *Leucosolenia atlantica* THACKER¹⁾, than to any other members of the same genus. It is, however, easily distinguished from THACKER's species by the form and dimensions of oxea and other spicules.

4. Leucosolenia laxa, KIRK

Leucosolenia laxa, KIRK, 1895, p. 208, Pl. IV., fig. 1; DENDY and Row, 1931, p. 722; HÔZAWA, 1928, p. 220, Pl. I., figs. 4, 5; 1940, p. 35; TANITA, 1941, p. 2, Pl. I., fig. 1; 1941, p. 265.

The collection contains many specimens of this species which were obtained from four different localities. They differ from one another in appearance.

The specimen from Tateyama, which was preserved in the Museum of the Tokyo University of Literature and Science, consists of a massive assemblage of reticulating Ascon-tubes and shows a yellowish-white tint in the preserved state.

The specimens from Awa-Kominato are either strongly compressed or small irregular massive colonies in form and their colour in alcohol is nearly white.

The remaining specimens which were secured at Kamakura and Shimoda form irregular, spreading masses consisting of a net-work of Ascon-tubes and are contaminated with mud, looking nearly grey.

With respect to the canal system, skeletal arrangement, and spiculations, all these specimens are identical with each other, and agree well with the description of this species given by previous writers.

Previously known Distributions:— New Zealand (KIRK); Mutsu Bay (HÔZAWA, TANITA); Rikuzen Ohshima (HÔZAWA); Onagawa Bay (TANITA),

Localities:— Awa-Kominato; Tateyama; Kamakura; Shimoda.

5. Leucosolenia mutsu HÔZAWA

(Pl. II, fig. 2)

Leucosolenia mutsu. HÔZAWA, 1928, p. 219, Pl. I., figs. 1, 2; 1940, p. 35; TANITA,. 1940,

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1) *Leucosolenia atlantica*, THACKER, Proc. Zool. Soc. London, Vol. 11, 1908, p. 760, Pl. XL., fig. 12, text-fig. 156.

p. 165, Pl. 8, fig. 1; 1941, p. 267.

There are numerous specimens of this species in the collection. Each of them represents an irregular, spreading mass composed of a loose network of Ascon-tubes. The largest specimen attains the length of about 20 mm.

The colour of the specimens varies from nearly white to grey in alcohol.

This species has been fully described by HÔZAWA (1928), thus no further details are necessary.

Previously known Distributions:— Mutsu Bay, Kesennuma Bay (HÔZAWA); Matsushima Bay, Onagawa Bay (TANITA).

Localities:— Shimoda; Kamakura; Misaki; Awa-Kominato; Sunosaki; Tateyama.

Remarks:— This species was first described by HÔZAWA, using the specimens taken from Mutsu Bay. Since that time, it has been reported by the same author and by the present writer as found in several localities. Judging from the distributions above mentioned, the present species seems to be rather common in the northern parts of Japan.

6. Leucosolenia protogenes (HAECKEL)

(Pl. II, fig. 3)

Ascetta primordialis var. *protogenes*, HAECKEL, 1872, p. 17, Taf. 1, 2, Taf. 5, figs. 1 a–i.
Ascetta procumbens, LENDENFELD, 1885, p. 1086, figs. 1–6.
Clathrina primordialis, CARTER, 1886, p. 510.
Leucosolenia protogenes, DENDY, 1891, p. 58, Pl. III., fig. 1, Pl. VI., fig. 1; DENDY and ROW, 1913, p. 726; DENDY and FREDERICK, 1924, p. 480, Pl. 25, fig. 2; BRØNDSTED, 1926, p. 297; BREITFUSS, 1932, p. 243; 1935, p. 13.
Clathrina procumbens, BRØNDSTED, 1923.

This species is represented by a single specimen which was obtained from Bôsyû Tateyama in 1920 and which is now deposited in the Museum of the Tokyo University of Literature and Science. The sponge forms an irregular, loose, massive colony consisting of Ascon-tubes, attaining about 25 mm in breadth and is attached by the lower surface to the substratum. The diameter of the Ascon-tubes varies from 0.4 mm to about 1 mm according to their position in the colony. The colour of the specimen in spirit is nearly white and the texture is soft.

The canal system, structure, and spicules of this species has been so fully described by the previous writers such as HAECKEL, DENDY, and LENDENFELD, that no further details are necessary.

Previously known Distributions:— South and East Coasts of Australia

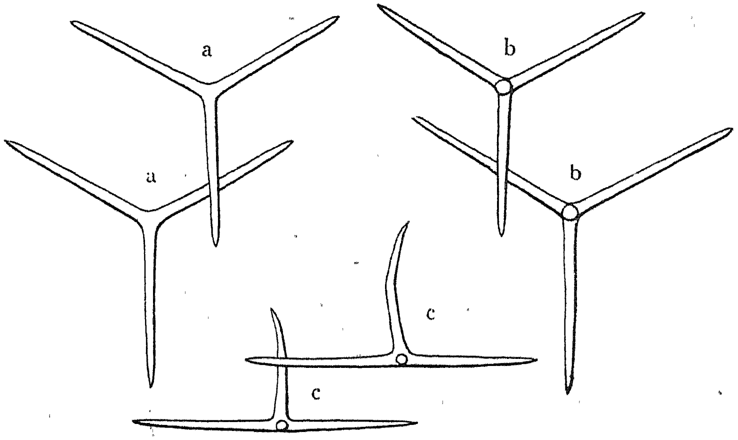
(HAECKEL, DENDY, LENDENFELD); West Coast of Australia (DENDY and FREDERICK); Campbell and Auckland Island (BRØNDSTED); New Zealand (BRØNDSTED).

Locality:— Bôsyû Tateyama.

7. **Leucosolenia serica**, n. sp.

(Pl. II, fig. 4; Text-fig. 2)

Three specimens of this new species exist in the collection. All of them were obtained by Dr. ERI from a depth of 100–200 fathoms at Yodomi in Sagami Sea. They are thin-walled elongate tubes, more or less laterally compressed and loosely branched. The total length of the sponges varies from 18 mm to 12 mm and the greatest breadth from 1 mm to 1.8 mm. The oscula in two of the specimens are entirely damaged but in the remaining one it is found at the upper end of the tube and is circular with a diameter of 1 mm. The gastral cavity is deep, extending throughout the entire length of the sponge. The dermal surface is smooth but the gastral is hispid due to the projecting apical rays of gastral quadriradiates.



Text-fig. 2. *Leucosolenia serica*, n. sp. a, triradiates of Ascon-tube; b, quadriradiates of Ascon-tube; c, side-view of the same. (all ×150)

The colour in alcohol is white and the texture is soft and delicate.

Structure:— The canal system seems to agree with DENDY's type simplicia[1]. The skeleton is made up of triradiates and quadriradiates, arranged in a single or double layer in the sponge wall. The apical rays of the latter kind of spicules project into the gastral cavity freely.

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[1] DENDY, A., Trans. Roy. Soc. Victoria, Vol. III, 1891, p. 24.

Spicules (Text-fig. 2):— Triradiates (a) regular, rays straight, nearly equally thick in their greater length and sharply pointed, 140–210 μ long and 7–8 μ thick at base.

Quadriradiates (b, c) also regular. Facial rays exactly similar to the triradiates. Apical ray which projects at right angles from the center of facial rays, curved near the sharp end, shorter and slightly thicker than facical rays, 90–135 μ long and 8–10 μ thick at base.

Locality:— Yodomi in Sagami Sea.

Remarks:— In external features this species closely resembles *Leucosolenia kagoshimensis* HÔZAWA[1] and in spiculation to *L. darwinii* (HAECKEL)[2]. But from HÔZAWA's species, the present species may be easily distinguished by the presence of triradiates and from HAECKEL's species, by the difference in external appearance, canal system, and dimension of spicules.

8. Leucosolenia stipitata DENDY

(Pl. II, fig. 5)

Leucosolenia stipitata, DENDY, 1891, p. 51, Pl. I., figs. 4–6, Pl. IV., fig. 2, Pl. IX., fig. 5; DENDY and ROW, 1913, p. 727; ROW and HÔZAWA, 1931, p. 739.

Two small specimens taken from Sunosaki and Awa-Kominato in Bôsyû Province are assigned to this species.

The specimen from Sunosaki (Pl. II, fig. 5) consists of a more or less oval body perched on the summit of a short stem by which the sponge is attached to the substratum. The total length of the sponge is only about 4 mm and the diameter of the body is about 2 mm. The colour in spirit is nearly white.

The specimen from Awa-Kominato is nearly the same in shape as that from Sunosaki but is slightly larger. The whole person is about 4.5 mm in height and 3 mm in diameter. The colour is grey due to the contamination with mud.

In general structure of the tubes, in the arrangement of the skeleton, and in other details, it correspond very closely to the original description given by DENDY.

Previously known Distributions:— Port Phillip Heads (DENDY); Geraldton District (Row and Hôzawa).

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[1] *Leucosolenia kagoshimensis*, HÔZAWA, 1929, p. 285, Pl. I., figs. 6, 7, text-fig. 3.

[2] *Ascetta darwinii*, HAECKEL, 1872, Bd. II, p. 57, Taf. 9, fig. 4, Taf. 10, figs. 3 a–c.

Localities:— Sunosaki and Awa-Kominato, Province Awa.

9. Leucosolenia tenera Tanita

Leucosolenia tenera, Tanita, 1940, p. 166, Pl. VIII., fig. 2, text-fig. 1; 1941, p. 2, Pl. I., fig. 2; 1941, p. 267.

Several specimens of this species exist in the collection, all being taken by the writer from the shore of Misaki and Sunosaki. Each of them forms a loose reticular mass, attached to the lower parts of the sea-weed.

With respect to the structure, spiculation, and etc., the present specimens are entirely identical with the type.

Previously known Distributions:— Matsushima Bay, Mutsu Bay, Onagawa Bay (Tanita).

Localities:— Misaki; Bôsyû Sunosaki.

10. Leucosolenia wilsoni Dendy

Leucosolenia wilsoni, Dendy, 1891, p, 63, Pl. II., figs. 3, 4, Pl. VIII., Pl. XI., fig. 3; Dendy and Row, 1913, p. 727.

There is a single specimen of this species in the collection. It was obtained by Dr. Eri in the neighbourhood of the Misaki Marine Biological Station together with other calcarea. The sponge forms a flattened, spreading mass, attaining the height of about 5 mm and the breadth of 12 mm. It has a few short, root-like processes raised from the lower surface of the colony, as in the type specimen. Small conical papillae on the upper surface which were described in the original paper, are not seen distinctly without a hand-lens, but this is because of the ill preservation of the material.

The skeleton consists of regular triradiate spicules only, which are arranged in several layers in the mesoderm. The rays of the spicules found in the dermal portion are longer and stouter than those found in the deep portion of the colony.

In spirit the specimen is nearly white but bears a faint greyish tint.

Previously known Distribution:— Near Port Phillip Heads (Dendy).

Locality:— Misaki.

II. Family Sycettidae DENDY

Genus Sycon RISSO

11. Sycon album, n. sp.

(Pl. II, fig. 6; Text-fig. 3)

This new species is based upon a single specimen contained in the collection. It was secured by Prof. YAICHIRO OKADA in 1931 from Okinoshima, off Tateyama.

It (Pl. II, fig. 6) has the form of an oval sac with a circular osculum which is surrounded by a developed collar at the upper end. The total length of the body is 9 mm, the greatest breadth is about 6 mm, and the body wall is 2.5 mm thick in the thickest parts. The osculum measures 2 mm in diameter and the oscular collar is about 1 mm high. The dermal surface is fairly hispid owing to the projecting oxea.

The colour in alcohol is nearly white and the texture is soft.

Structure:— The canal system is of the syconoid type. The radial chambers are very long and narrow and branch repeatedly, the branches running parallel and becoming narrower as they approach the dermal surface.

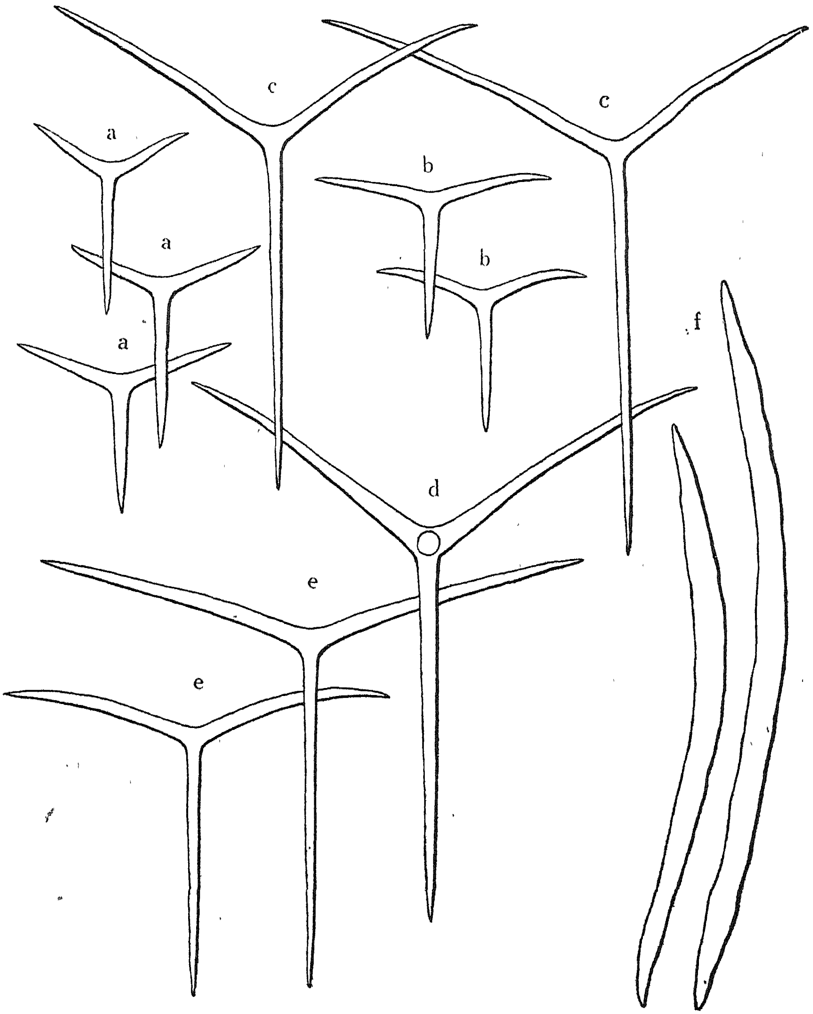
The tubar skeleton is composed of the basal rays of subgastral triradiates and of the articulated tubar triradiates. At the distal end of the flagellate chambers there occur loose tufts of oxea. The gastral skeleton is very thin, formed of the paired rays of subgastral triradiates and of the tangentially placed gastral tri- and quadriradiates with their basal rays pointing downwardly and with apical rays projecting into the gastral cavity.

The oscular margin is composed of oxea, linear spicules, triradiates, and quadriradiates, all being closely set. The oxea and linear spicules are placed longitudinally forming a thin fringe. The basal rays of tri- and quadriradiates are directed downwardly.

Spicules (Text-fig. 3):— Tubar triradiates (a) slightly sagittal. Rays nearly equally thick. Basal ray straight, slightly longer than paired rays, 90–115 μ long and 8–10 μ thick at base. Paired rays gently curved forwards, 70–85 μ long and 8–10 μ thick at base.

Subgastral triradiates (b) similar to tubar triradiates, differing only in the divergence of paired rays. Paired rays strongly divergent, slightly curved backwards and stand at nearly right angles to basal ray.

Gastral triradiates (c) sagittal. All rays are slender and nearly equally thick being 8–12 μ. Basal ray straight, sharply pointed, longer than paired rays and 180–260 μ long. Paired rays equal, slightly curved backwards, tapering to sharp end and 160–220 μ long.



Text-fig. 3. *Sycon album*, n. sp. a, tubar triradiates; b, subgastral triradiates; c, gastral triradiates; d, gastral quadriradiate; e, triradiates of oscular margin; f, oxea at the distal end of flagellate chambers. (all ×210)

Gastral quadriradiates (d) exactly similar to gastral triradiates, except for the presence of apical ray. Apical ray curved oralwards, gradually and sharply pointed, 70–180 μ long and 7–10 μ thick at base.

Triradiates of oscular margin (e) strongly sagittal. Basal ray straight, tapering to sharp end, slightly thinner than paired rays, 180–240 μ long and 7–10 μ thick at base. Paired rays strongly divergent, curved backwards, shorter than basal ray, 150–200 μ long and 9–13 μ thick at base.

Quadriradiates of oscular margin nearly equal to the triradiates of the same portion, but differ only in the presence of apical ray. Apical ray slightly curved, shorter than facial rays, about 65 μ long and 10 μ thick at base.

Oxea at the distal end of flagellate chambers (f) elongated spindle-shaped, sharply pointed at both ends, uneven in outline, 230–470 μ long and 9–20 μ thick in the thickest parts.

Linear spicules of the oscular margin very slender, straight, and uniformly thick through the entire length, reaching to 1.2 mm in length by 2–5 μ thick.

Locality:— Okinoshima, off Bôsyû Tateyama.

Remarks:— This species may be easily distinguished from other members of the genus by the repeatedly branched flagellate chambers and by the proportion of the tubar triradiates to the gastral radiates.

12. **Sycon cylindricum**, n. sp.

(Pl. II, fig. 7; Text-fig. 4)

Of this new species only a single specimen exists in the collection being obtained by the writer in the neighbourhood of the Mitsui Institute of Marine Biology, near Shimoda.

The sponge (Pl. II, fig. 7) consists of a solitary individual, of nearly cylindrical form and is attached by its base to the substratum directly. It is 7.5 mm in total length and is about 3 mm in greatest breadth. The osculum at the upper end is circular with a diameter of 1 mm and is surrounded by a very feebly-developed collar. The sponge wall measures in thickness about 1.2 mm in the middle parts of the body and it becomes gradually thinner nearer the osculum. The outer surface of the sponge is rough owing to the projecting oxea, while the inner appears smooth to the naked eye but is perforated in a mesh-like manner by the openings of exhalant canals.

The colour is yellowish-white in the preserved state and the texture is rather firm and elastic.

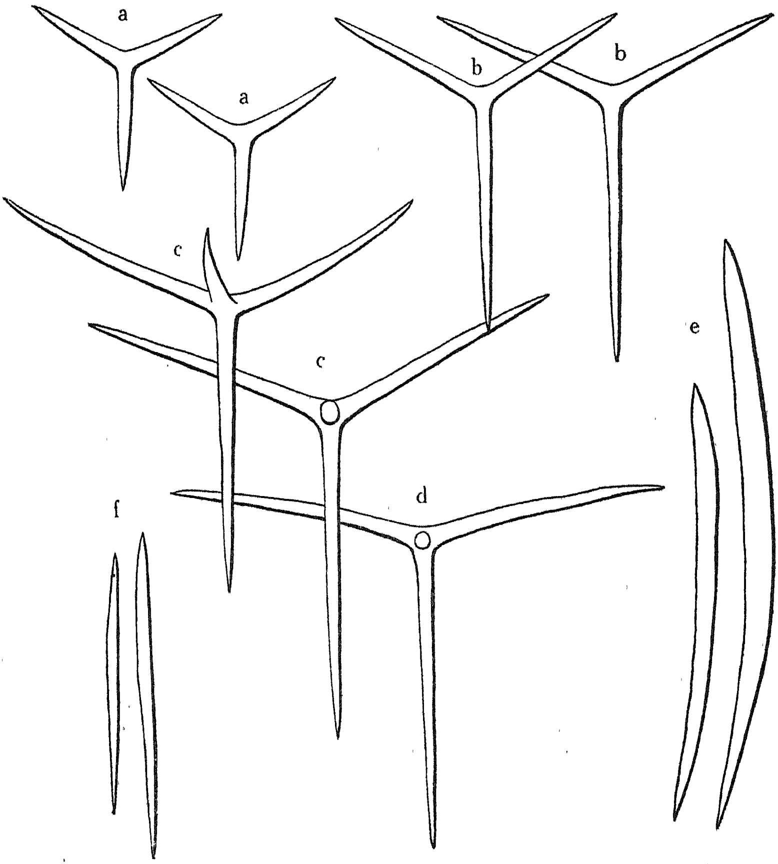
Structures:— The canal system is of the syconoid type. The flagellate chambers are nearly straight and are divided into two or three branches distally. The branches run parallel with one another towards the dermal surface terminating in low rounded distal cones.

The skeleton of the flagellate chambers is of the ordinary articulated type consisting mainly of small tubar triradiates. The basal rays of the most distally placed triradiates are converged so as to cover the tip of the flagellated chambers together with the tuft of oxea, which consist of two kinds, larger and smaller. The basal rays of subgastral triradiates may be added to the same skeleton.

The gastral skeleton is composed of paired rays of subgastral triradiates and the tangentially arranged gastral tri- and quadriradiates. The gastral quadriradiates are smaller in number when compared with the triradiates and their apical rays project into the gastral cavity.

The gastral skeleton is continuous with the skeleton of the oscular collar which forms the oscular rim. In the rim the triradiates almost disappear. There is a fringe composed of longitudinally arranged oxea which are almost the same as those found at the distal ends of the flagellate chambers.

Spicules (Text-fig. 4) :— Tubar triradiates (a) slightly sagittal. All rays



Text-fig. 4. *Sycon cylindricum*, n. sp. a, tubar triradiates; b, gastral triradiates; c, gastral quadriradiates; d, quadriradiate of oscular margin; e, large oxea at the distal end of flagellate chambers; f, small oxea of the same. (all ×210) are nearly equal in thickness being 8–10 μ. Basal ray straight, longer than paired rays and 90–115 μ long. Paired rays nearly equal, slightly curved forwards, tapering to sharp point and 65–80 μ long.

Subgastral triradiates almost like tubar triradiates but with wider oral angles.

Gastral triradiates (b) sagittal. Basal ray straight, sharply pointed, longer than paired rays, 180–230 μ long and 7–10 μ thick at base. Paired rays equal, almost straight or very slightly curved forwards, 130–180 μ long and 7–10 μ thick at base.

Gastral quadriradiates (c) exactly similar to gastral triradiates, except for the presence of apical ray. Apical ray curved upwards, sharply pointed, shorter than facial rays, 60–120 μ long and 8–10 μ thick at base.

Quadriradiates of oscular margin (d) sagittal and like gastral quadriradiates, but the paired rays are more widely divergent.

Large oxea (e) elongate spindle shaped, usually slightly curved, sharply pointed at both ends, 320–550 μ long and 17–25 μ thick in the thickest parts.

Small oxea at the distal end of flagellate chambers (f) nearly straight, spindle shaped, finely pointed at both ends, 170–250 μ long and 5–10 μ thick in the thickest parts.

Locality:— Susaki, near Shimoda.

Remarks:— The peculiarities of this species are the presence of two sorts of oxea at the distal ends of flagellate chambers and that the flagellate chambers are divided distally into two or three branches. Only a few species of *Sycon* are known to have branched radial chambers. The present species is closely related to *Sycon album* above described, but it may be easily distinguished from the latter by general structure and by the oxea at the distal ends of the flagellate chambers.

13. Sycon luteolum, n. sp.

(Pl. II, fig. 8; Text-fig. 5)

This new species is represented in the collection by twelve specimens of various sizes. They were obtained from the two different localities of Awa-Kominato and Kamakura. All specimens are solitary, each being a more or less laterally compressed tubular or oval individual attached by the narrowed base directly to the foreign body and is provided with an osculum at the upper end.

I have selected the largest specimen (Pl. II, fig. 8) from Awa-Kominato on which to base further descriptions. It is an individual of nearly oval shape, with two protuberances near the lower end, measuring 9 mm in length and 6 mm broad at the greatest breadth. The osculum at the upper end is circular in shape with a diameter of about 1 mm and is surrounded by a well-developed collar. The body wall is 2.7 mm thick in the middle of the body. The outer surface is strongly hispid due to the presence of oxea projecting from it. The gastral surface is also hispid owing to the projecting apical rays of gastral quadriradiates.

The colour in alcohol is yellowish-grey and the texture is rather firm and moderately elastic.

Structures :— The canal system is of the syconoid type. The radial flagellated chambers are narrow, elongated, and are divided into two branches distally. They are set closely, touching the others at all of their length and thus the distal ends of the flagellate chambers seem to form a thin dermal cortex together with the tufts of large and small oxea.

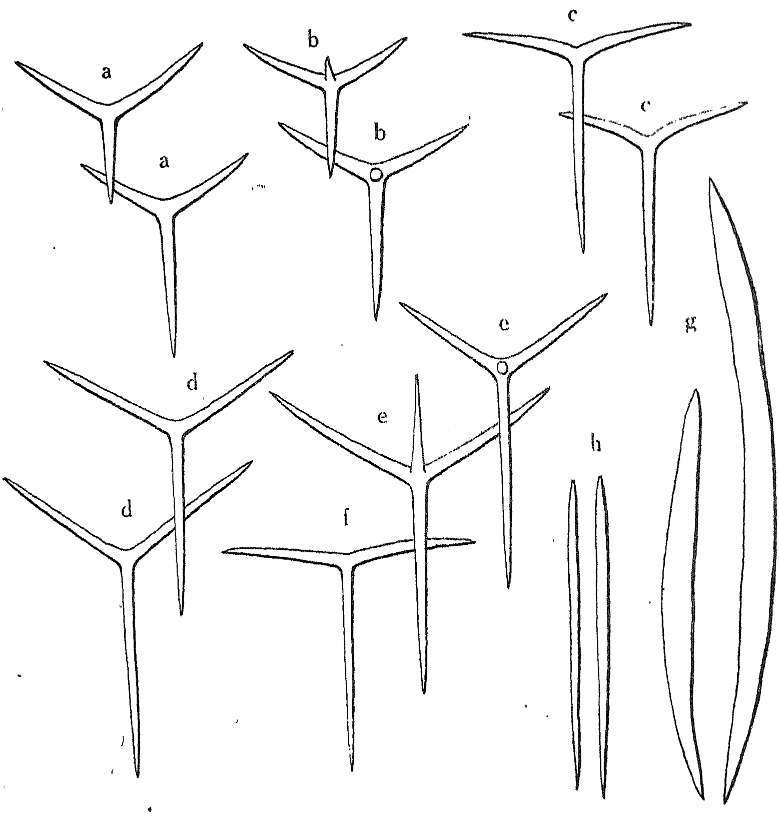
The tubar skeleton is arranged as usual, being composed of the basal rays of subgastral triradiates and of tubar tri- and quadriradiates arranged in several layers. The apical rays of the tubar quadriradiates project into the cavity of the flagellate chamber and are directed slightly towards the exhalant aperture of the same. At the distal end of the flagellate chambers, the oxea and the basal rays of the outermost radiates form the distal tufts.

The gastral skeleton is rather thick and is formed of the paired rays of subgastral triradiates and of gastral tri- and quadriradiates which are tangentially arranged with their long apical rays projecting into the gastral cavity. The skeleton of oscular margin is a close interlacement of longitudinally placed linear spicules and of triradiates which have strongly divergent paired rays and downwardly directed basal rays.

Spicules (Text-fig. 5) — Tubar triradiates (a) slightly sagittal. Basal ray straight, tapering to sharp point, slightly longer than paired rays, 85–140 μ long and about 10 μ thick at base. Paired rays equal, slightly curved forwards, 80–95 μ long and 10 μ thick at base.

Tubar quadriradiates (b) differ only from the foregoing in the development of a short, curved, sharply pointed apical ray, measuring about 40 μ long and 8–10 μ thick at base.

Subgastral triradiates (c) strongly sagittal. All rays are nearly equally thick being 8–10 μ. Basal ray straight, sharply pointed, longer than paired rays and 110–165 μ long. Paired rays widely divergent and 80–95 μ long.



Text-fig. 5. *Sycon luteolum*, n. sp. a, tubar triradiates; b, tubar quadriradiates; c, subgastral triradiates; d, gastral triradiates; e, gastral quadriradiates; f, triradiate of oscular margin; g, large oxea at the distal end of flagellate chambers; h, small oxea of the same. (a–f, h ×150, g ×90)

Gastral triradiates (d) sagittal. Basal ray straight, longer than paired rays, 140–240 μ long and 7–10 μ thick at base. Paired rays equal, either straight or slightly curved forwards, 80–160 μ long and 7–10 μ thick at base.

Gastral quadriradiates (e) nearly similar to gastral triradiates, differing only in the presence of apical ray. Apical ray well developed, slightly curved oralwards, sharply pointed, 80–220 μ long and 6–7 μ thick at base.

Triradiates of oscular margin (f) sagittal. Basal ray straight, tapering to sharp point, 120–200 μ long and 6–8 μ thick at base. Paired rays equal, strongly divergent, slightly thicker than basal ray, 80–140 μ long and 8–10 μ thick at base.

Large oxea at the distal end of flagellate chambers (g) elongate spindle shape, usually curved, sharply pointed at both ends, 420–900 μ long and 20–50 μ thick at the thickest parts.

Small oxea of the same (h) slender, nearly straight, sharply pointed at both ends, 270–380 μ long and 6–12 μ thick at the thickest parts.

Linear spicules at the oscular margin slender, straight, nearly uniformly thick in the greater parts of their length, 2 mm long or more by 4–8 μ thick.

Localities :— Awa-Kominato; Kamakura.

Remarks :— This species seems to be quite distinct from any of the hitherto known species in three characteristics: 1) the flagellate chambers are divided, 2) a feebly developed dermal cortex is present, and 3) the tubar quadriradiates are present. Only one species, *Sycon giganteum* DENDY[1], has branched flagellated chambers and tubar quadriradiates, but it has no dermal cortex.

14. Sycon matsushimense TANITA

Sycon Matsushimense, TANITA, 1940, p. 168, Pl. VIII., fig. 4, text-fig. 2.

This species is represented in the collection by twelve specimens which were obtained from the three different localities of Awa-Kominato, Sunosaki, and near Shimoda. They are all small in size, being from 3.5 mm to 8 mm in length. The sponge has the form of an elongated sac with a circular osculum surrounded by a well-developed collar at the upper end. The colour in alcohol is nearly grey and the texture is soft.

In respect to the anatomical structures, all specimens above mentioned are identical with the type which was first described by the present writer.

Previously known Distribution :— Matsushima Bay (TANITA).

Localities :— Awa-Kominato; Bôsyû Sunosaki; near Shimoda.

15. Sycon misakiensis HÔZAWA

(Pl. II, fig. 9)

Sycon misakiensis, HÔZAWA, 1929, p. 300, Pl. III., figs. 16, 17, text-fig. 9; 1940, p. 37.

This species is represented by 22 specimens in the collection, two of which were obtained by Prof. YAICHIRO OKADA at Sunosaki and the remaining ones by Dr. ERI in the neighbourhood of the Misaki Marine Biological Station. They are all of a closely similar appearance. Each specimen forms a solitary tubular individual, attached by a narrowed base to the foreign object and showing at the upper end an osculum which is surrounded by a feebly developed collar.

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[1] *Sycon giganteum*, DENDY, 1892. p. 84.

The greatest specimen (Pl. II, fig. 9) which came from Sunosaki, measures 17 mm in length and 6 mm in greatest breadth.

The colour of the specimens from Sunosaki in alcohol is white, while that of the specimens from Misaki is grey.

Previously known Distributions:— Misaki; Rikuzen Ohshima (Hôzawa).

Localities:— Misaki; Bôsyû Sunosaki.

16. **Sycon rotundum** Tanita

Sycon rotundum, Tanita, 1941, p. 270, Pl. 17, fig. 5, text-fig. 2.

The collection contains many specimens of this species. They were collected by the writer on the shore of Awa-Kominato and in the neighbourhood of the Misaki Marine Biological Station. They are closely similar to one another in appearance, though vary in size. The sponge forms a solitary spherical individual, showing at the upper end an osculum surrounded by a well-developed collar. The largest specimen measures 5 mm in height and 3 mm in greatest breadth. The oscular collar is 1 mm high. The colour is grey, being contaminated with mud.

In anatomical structure and spiculation, the present specimens are identical with the type, so that there is no need to add further descriptions.

Previously known Distribution:— Onagawa Bay (Tanita).

Localities:— Misaki; Awa-Kominato.

III. Family **Heteropiidae** Dendy

Genus **Grantessa** von Lendenfeld

17. **Grantessa intusarticulata** (Carter)

(Pl. II, fig. 10)

Hypograntia intusarticulata, Carter, 1885–1886, p. 45.

Hypograntia medioarticulata, Carter, 1885–1886, p. 46.

Grantessa intusarticulata, Dendy, 1892, p. 108; 1893, p. 181, 201, Pl. XIII., fig. 18; Dendy and Row, 1913, p. 753; Hôzawa, 1916, p. 14, Pl. I., fig. 4, Pl. II., fig. 13, text-fig. 3; 1929, p. 318; 1933, p. 7; 1940, p. 37; Brøndsted, 1926, p. 308; Row and Hôzawa, 1931, p. 775.

Grantia intusarticulata, Breitfuss, 1897, p. 219.

Ten specimens of this species were collected at Misaki, Kamakura, and Shimoda. Each of the specimens represents a colony composed of several tubular individuals joined together at their bases. The colour of specimens in alcohol vary from nearly white to grey.

With respect to the canal system, skeletal arrangement, and spiculation, these specimens are exactly identical with the description of this species given by previous writers.

Previously known Distributions:— Near Port Phillip Head (CARTER, DENDY); Watson's Bay, Port Jackson (DENDY); Island Bay, Welligton, N. Z. (BRØNDSTED); Geraldton District, S. W. Australia (ROW and HÔZAWA); Sunosaki, Misaki, Wagu in Mie Prefecture, Noto Wajima (HÔZAWA).

Localities:— Misaki; Kamakura; Shimoda.

Remarks:— This species was first described by CARTER (1886), using the specimens taken from Australia. Since that time, it has been reported by several other writers as found in Australia and New Zealand. From Japanese waters, the occurrence of this species was reported three times, in 1916, 1933, and 1940 by HÔZAWA, dealing with the specimens obtained from several different localities.

Judging from the facts above mentioned, the present species seems to be widely distributed all over the world.

18. **Grantessa mitsukurii** HÔZAWA

(Pl. II, fig. 11)

Grantessa mitsukurii, HÔZAWA, 1916, p. 23, Pl. I., fig. 7, Pl. II., fig. 15, text-fig. 5; 1929, p. 318.

This species is represented by seven specimens which were obtained from the twe different localities of Tateyama and Awa-Kominato. The specimens from Tateyama were preserved in the Museum of the Tokyo University of Literature and Science. Each of these specimens represents an irregular colony provided with several oscula. The largest specimen (Pl. II, fig. 11) which is 25 mm high and about 27 mm broad is strongly laterally compressed, with four oscula. The dermal surface is nearly smooth, and the colour is white in the preserved state.

The specimen from Awa-Kominato is rather small and the colour is grey.

Previously known Distribution:— Misaki (HÔZAWA).

Localities:— Tateyama; Awa-Kominato.

Remarks:— This species was first described by HÔZAWA using a single specimen obtained from Misaki. This is, therefore, the second report dealing with the occurrence of this species in Japan.

19. **Grantessa parva**, n. sp.

(Pl. II, fig. 12; Text-fig. 6)

This new species is based upon a single specimen which was obtained by Dr. ERI in 1932 in the neighbourhood of the Misaki Marine Biological Station. The sponge (Pl. II, fig. 12) represents a solitary individual of a small cylindrical form and is provided with a naked osculum at the upper end. The lower end of the body curves abruptly. It is about 12 mm long and 1.2 mm in greatest breadth. The sponge wall is about 0.5 mm thick in the middle part of the body. The osculum is elliptical with a diameter of 1 mm by 0.7 mm. The dermal surface is smooth and even, but the gastral is fairly rough owing to the projecting apical rays of the gastral quadriradiates.

The colour in alcohol is white and the texture is very soft.

Structures:— The canal system is syconoid. The flagellate chambers are arranged radially. They are straight, unbranched, and circular in cross-section.

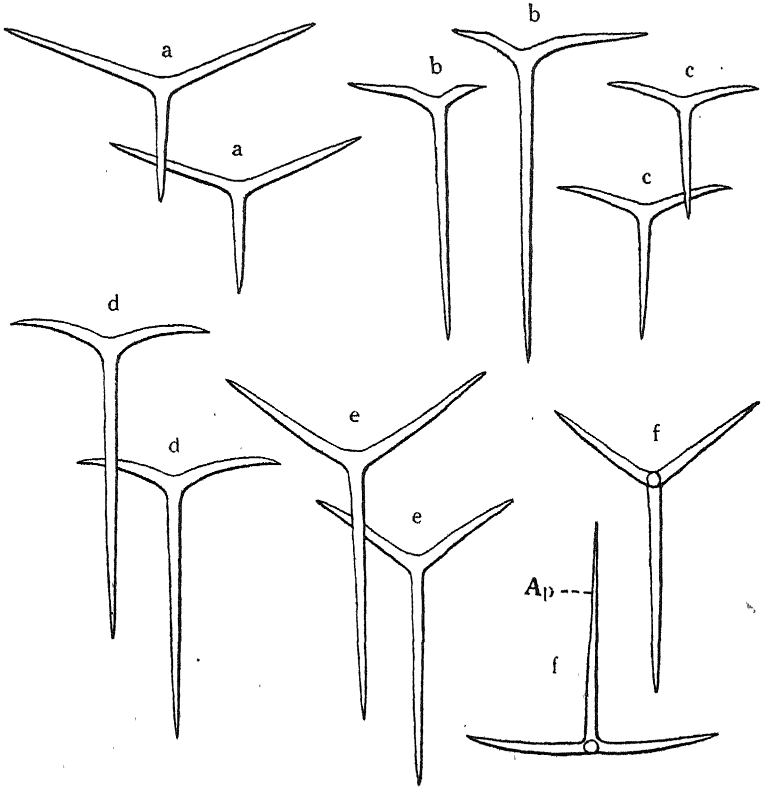
The dermal skeleton is very thin, composed of tangentially placed sagittal triradiates and of paired rays of subdermal pseudosagittal triradiates. The tubar skeleton is mainly made up of the centripetal basal rays of the subdermal triradiates and of the centrifugal basal rays of the subgastral triradiates. In addition to these spicules above mentioned, the tubar skeleton recieves a few sagittal tubar triradiates with their basal rays directed centrifugally. The gastral skeleton is more strongly developed than the dermal, consisting of tangentially arranged gastral tri- and quadriradiates and of paired rays of the subgastral triradiates.

Spicules (Textfig. 6):— Dermal triradiates (a) sagittal. All rays are of equal thickness being 8–10 μ at base, tapering from base to a sharp point. Basal ray straight, shorter than paired rays and 65–95 μ long. Paired rays nearly equal, widely divergent and 110–150 μ long.

Subdermal triradiates (b) pseudosagittal. All rays are of different length but are of nearly equal thickness. Basal ray straight, sharply ended, much longer than paired rays, 180–250 μ long and 8–12 μ thick at base. Paired rays unequal in length; the longer ray curved backwards and rather gradually and sharply pointed, 80–110 μ long and 8–12 μ thick at base. The shorter ray either straight or slightly curved backwards, 50–70 μ long and 8–12 μ thick at base.

Tubar triradiates (c) slightly sagittal. Rays are of the same thickness being 8–10 μ. Basal ray straight, sharply pointed, slightly longer than paired rays and 100–150 μ long. Paired rays equal, widely divergent, slightly curved backwards, 70–120 μ long.

Subgastral triradiates (d) strongly sagittal. Basal ray straight, much longer than paired rays, 170–260 μ long and 8–12 μ thick at base. Paired rays widely divergent, curved backwards, 70–110 μ long and 8–12 μ thick at base.



Text-fig. 6. *Grantessa parva*, n. sp. a, dermal triradiates; b, subdermal triradiates; c, tubar triradiates; d, subgastral triradiates; e, gastral triradiates; f, gastral quadriradiate; f′, side-view of the same. (all ×150)

Gastral triradiates (e) also sagittal. Basal ray straight, 190–300 μ long and about 8 μ thick at base. Paired rays equal, nearly straight or slightly curved, shorter than basal ray, 100–160 μ long and 8 μ thick at base.

Gastral quadriradiates (f) almost like the gastral triradiates with addition of an apical ray. Apical ray well-developed, either straight or curved oralwards, fairly sharply pointed, 110–230 μ long and 6–8 μ thick at base.

Locality:— Misaki.

Remarks:— This new species bears a close resemblance to *Grantessa glacilis* (HAECKEL)[1] in external features, but it may be easily distinguished from the latter by the shape of spicules and by the presence of tubar and gastral triradiates.

20. **Grantessa shimeji** HÔZAWA

(Pl. III, fig. 13)

Grantessa shimeji, HÔZAWA, 1916, p. 2, Pl. I., figs. 1, 2, Pl. II., figs. 10, 11, text-fig. 1; 1929, p. 315.

Of this species three specimens contained in the collection were examined by myself.

The first specimen was obtained by means of a lobster net in the neighbourhood of the Shimoda Marine Biological Station of Tokyo University of Literature and Science. It forms an irregular small colony with a height of about 20 mm. The colony consists of several cylindrical and erect tubes.

The second (Pl. III, fig. 13) and the third specimens were secured by Dr. MOTOMURA in the neighbourhood of the Misaki Marine Biological Station. They are nearly the same in size and shape forming an irregular hemispherical colony, consisting of numerous subcylindrical tubes. One of these tubes measured 28 mm in height and 3.5 mm in maximum diameter.

Previously known Distributions:— Misaki, Shima Ohshima (HÔZAWA).

Localities:— Misaki; Shimoda.

21. **Grantessa shimoda**, n. sp.

(Pl. III, fig. 14; Text-fig. 7)

A single specimen of this new species exists in the collection and it was obtained by the writer from a depth of about 5 meters in Shimoda Bay.

It (Pl. III, fig. 14) is a small solitary individual of a tubular form, measuring 7 mm long and about 2.5 mm broad in the middle parts. The outer surface is strongly hispid due to the presence of large oxea projecting from it. The osculum at the upper end is nearly circular with a diameter of about 1 mm. The gastral cavity is relatively narrow and straight, extending through the entire length of body. The gastral surface is slightly hispid from the projecting apical rays of the gastral quadri radiates.

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[1] *Sycaltis glacilis*, HAECKEL, 1872, p. 269, Taf. 45, figs. 4–7.

The colour in alcohol is nearly white with a faint greyish tint and the texture is firm.

Structures:— The canal system is of the syconoid type. The flagellate chambers are straight, unbranched, and are arranged radially. The dermal skeleton is rather thick, being composed of a few layers of dermal triradiates, of paired rays of subdermal pseudosagittal triradiates, and of large oxea. The large oxea occur here and there in vertical position in the sponge wall with their distal end projecting outwards and their proximal parts reaching the gastral skeleton.

The tubar skeleton is made up of 1) the centripetal basal rays of subdermal pseudosagittal triradiates; 2) several intermediate rows of tubar triradiates with outwardly directed basal rays; 3) the centrifugal basal rays of subgastral tri- and quadriradiates; and 4) the proximal parts of large oxea.

The gastral skeleton consists of the paired rays of subgastral tri- and quadriradiates and of the tangentially arranged gastral quadriradiates, with their apical rays projecting into the gastral cavity.

The skeleton of the oscular margin is composed of the dermal and gastral spicules and of large oxea running longitudinally.

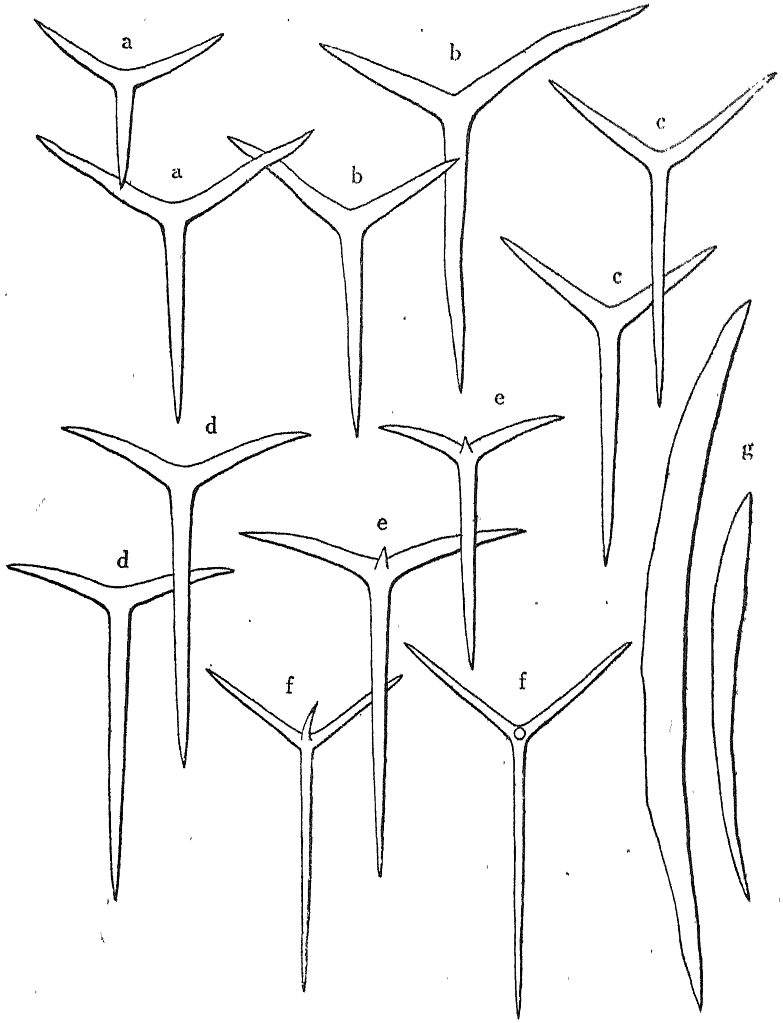
Spicules (Text-fig. 7):— Dermal triradiates (a) slightly sagittal. Basal ray straight, gradually sharp-pointed, nearly equal to or longer than paired rays, 150–200 μ long and 15–20 μ thick at base. Paired rays nearly equal, curved forwards, 150–180 μ long and 15–20 μ thick at base.

Subdermal triradiates (b) pseudosagittal. All rays are of equal thickness being 15–20 μ. Basal ray straight or nearly so, longer than paired rays and measures in length 180-240 μ. Paired rays are of different length and shape. The longer of them tapers to a sharp point, being bent in the middle parts, 140–180 μ long. The shorter ray is nearly straight, sharply pointed, 100–120 μ long.

Tubar triradiates (c) sagittal. Basal ray straight, tapering to sharp end, longer than paired rays, 170–250 μ long and 12–18 μ thick at base. Paired rays equal, either straight or slightly curved forwards, 105–150 μ long and 12–18 μ thick at base.

Subgastral triradiates (d) strongly sagittal. Basal ray straight, sharply pointed, much longer than paired rays, 240–300 μ long and 14–20 μ thick at base. Paired rays equal, slightly curved backwards, diverging widely, 90–145 μ long and 14–20 μ thick at base.

Subgastral quadriradiates (e) exactly similar to subgastral triradiates except for the presence of a short apical ray. Apical ray very short,



Text-fig. 7. *Grantessa shimoda*, n. sp. a, dermal triradiates; b, subdermal triradiates; c, tubar triradiates; d, subgastral triradiates; e, subgastral quadriradiates; f, gastral quadriradiates; g, oxea. (a–f ×150, g ×90)

thinner than facial rays, about 40 μ long and 8 μ thick at base.

Gastral quadriradiates (f) sagittal and the rays are slender. Basal ray sharply pointed, longer than paired rays, 200–350 μ long and about 10 μ thick at base. Paired rays nearly equal, either straight or slightly curved forwards, 100–160 μ long and 10 μ thick at base. Apical ray curved oralwards, finely pointed, shorter and thinner than facial rays, 70–110 μ long and about 8 μ thick at base.

Oxea (g) more or less curved, sharply pointed at both ends, the broadest part often lying nearer the distal end than the proximal, considerably varying in length and in thickness, 650 μ–1.3 mm long and 55–80 μ thick at the broadest parts.

Locality:— Shimoda Bay.

Remarks:— The above described species closely resembles *Grantessa sagamiana* HÔZAWA[1] in external form, but differs from the latter in the presence of subgastral quadriradiates, in the absence of gastral triradiates, and in the shape of other spicules.

Genus **Heteropia** CARTER

22. **Heteropia striata** HÔZAWA

(Pl. III, fig. 15)

Heteropia striata, HÔZAWA, 1916, p. 28, Pl. I., fig. 8, Pl. II., fig. 16, text-fig. 6; 1929, p. 318.

This species is represented by seven specimens in the collection and they are preserved in the Museum of the Misaki Marine Biological Station. One of them which was collected from a depth of about 100 fathoms of Daibusa, Bôsyû, is a small solitary person of tubular form with slightly yellowish colour. The remaining six specimens were obtained by Dr. ERI in the neighbourhood of the Misaki Marine Biological Station.

The largest specimen (Pl. III, fig. 15) is a small colony consisting of nine tubular individuals, united together at their bases. All of the individuals are provided with a circular osculum at their upper ends. The largest individual measures 25 mm in total length and 3 mm in greatest breadth, the osculum reaching about 2 mm in diameter. The dermal surface of the sponge shows a distinct striation owing to the presence of large oxea in dermal cortex. The colour in the preserved state is pale brown.

With respect to the canal system, skeletal arrangement and spiculation, these specimens are exactly identical with the type specimen.

Previously known Distributions:— Koajiro and Abratsbo, near Misaki (HÔZAWA).

Localities:— Misaki; Bôsyû Daibusa.

Remarks:— This species was first described by HÔZAWA, using the specimens obtained from Koajiro and Abratsbo. The present record, therefore, is the second report dealing with the occurrence of this species in Japanese waters.

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[1] *Grantessa sagamiana*, HÔZAWA, 1916, p. 8, Pl. I., fig. 3, Pl. II, fig. 12.

Genus Amphiute HANITSCH

23. Amphiute ijimai HÔZAWA

(Pl. III, fig. 16)

Amphiute ijimai, HÔZAWA, 1916, p. 33, Pl. I., fig. 9, Pl. II., fig. 17, text-fig. 7; 1929, p. 313; 1933, p. 8, Pl. I., fig. 4.

In the collection of this species there is a single specimen (Pl. III, fig. 16) which was secured in 1938 from a depth of 60 fathoms off Zyôgashima, near Misaki, and which was preserved in the Museum of the Misaki Marine Biological Station.

The sponge is of an elongated tube, broadest at a part a little below the middle and becomes gradually narrower towards both ends. The total length is 84 mm and the greatest diameter is about 17 mm. An osculum at the upper end of body is naked and is nearly circular in shape with a diameter of about 7 mm. The body wall is about 2 mm thick in the middle parts of the sponge body. The gastral cavity is deep and extends through the entire length of the sponge body. The colour in alcohol is white.

In external features, internal structures, and in the spiculation, the present specimen conforms very well with the type.

Previously known Distributions:— Doketsba in Sagami Sea, Senoumi in Suruga Bay (HÔZAWA).

Locality:— Off Zyôgashima near Misaki.

Genus Vosmaeropsis DENDY

24. Vosmaeropsis japonica HÔZAWA

(Pl. III, fig. 17)

Vosmaeropsis japonica, HÔZAWA, 1929, p. 324, Pl. VI., figs. 34, 35, text-fig. 18; 1940, p. 143, Pl. VI., fig. 6.

Nine specimens in the collection were assigned to this species. Two of them were collected by Dr. ERI at Abratsbo, one at Nakôzaki by the same person, one by Prof. OKADA off Tateyama, and the remaining five were secured by the writer in the neighbourhood of the Mitsui Institute of Marine Biology, near Shimoda.

The largest specimen (Pl. III, fig. 17) which was obtained from Abratsbo is a solitary individual of a more or less laterally compressed cylindrical form and is narrowed towards the upper end where an osculum is situated. It is 23 mm long, 11 mm broad at the broadest parts, and about 6 mm thick in the middle parts of the body. The dermal surface is highly hispid owing to the projecting oxea.

The colour of the specimens is grey or nearly so, and the texture is moderately elastic.

With regard to the canal system, internal structure, spicules, etc., the present specimens seem to agree well with the type specimen.

Previously known Distribution:— Sagami Sea (Hôzawa).

Localities:— Misaki; Nokôzaki; Tateyama; Shimoda.

25. **Vosmaeropsis maculata** Hôzawa

(Pl. III, fig. 18)

Vosmaeropsis maculata, Hôzawa, 1929, p. 321, Pl. V., figs. 32, 33, text-fig. 17; Tanita, 1941, p. 273, Pl. 17, fig. 6.

Numerous specimens of this species obtained from three different localities exist in the collection. Two of them were secured in the neighbourhood of Misaki, five were collected from Shimoda, and the remaining ones were obtained in the neighbourhood of Awa-Kominato. Each of them is provided with a naked circular osculum at the upper end. The dermal surface appears smooth but is not quite even. They vary from 4 mm to 17 mm in length.

One of the specimens taken from Shimoda (Pl. III, fig. 18) is nearly spherical in form and is attached by its base to some calcareous alga.

The colour of the specimens preserved in alcohol varies from greyish-white to nearly white.

Previously known Distributions:— Misaki, Enoura in Suruga Bay (Hôzawa); Onagawa Bay (Tanita).

Localities:— Misaki; Shimoda; Awa-Kominato.

IV. Family **Grantiidae** Dendy

Genus **Ute** O. Schmidt

26. **Ute pedunculata** Hôzawa

(Pl. III, fig. 19)

Ute pedunculata, Hôzawa, 1929, p. 334, Pl. VI., figs. 40, 41, text-fig. 21.

Only a single specimen of this species exists in the collection. It was obtained by Dr. ERI from a depth of about 100 fathoms at Yodomi in Sagami Sea. The sponge is a solitary individual, provided with a short peduncle. The body is in the form of a nearly straight tube with a naked osculum at its upper end. The total length of the specimen is 5.2 mm and the maximum breadth is 1.3 mm. The dermal surface is slightly hispid when observed with the hand-lens, due to the projecting hair-like spicules. The osculum is nearly circular in shape, measuring about 0.7 mm in diameter. The specimen preserved in alcohol is white in colour.

Previously known Distribution:—Sagami Sea (HÔZAWA).

Locality:—Yodomi in Sagami Sea

Remarks:—The present species was first described by HÔZAWA (1929), basing the description upon a specimen which came from Sagami Sea. Thus this is the second record of this species as found in Japanese waters, although the locality is very close to that of the type specimen. The type specimen, as described by HÔZAWA, was obtained from a depth of 114 meters in the Sagami Sea, while the present specimen was secured from a depth of about 100 fathoms, thus this species seems probably to be found in deep sea only.

Genus Leucandra HAECKEL

27. **Leucandra abratsbo** HÔZAWA

Leucandra abratsbo, HÔZAWA, 1929, p. 359, Pl. IX., figs. 57, 58, text-fig. 29; 1940, p. 53; TANITA, 1941, p. 273, Pl. 17, fig. 7.

In the collection there are numerous specimens of this species which were obtained from six different localities. Several of them were secured by Prof. OKADA at Tateyama, some others by Dr. ERI in the neighbourhood of the Misaki Marine Biological Station, while the remaining ones were collected by the writer at Awa-Kominato, Sunosaki, Misaki, Kamakura, and Shimoda. They vary in size, in shape, and in colour considerably. The largest specimen forms a solitary individual with a height of 31 mm and the greatest breadth is of about 15 mm.

Previously known Distributions:—Misaki, Noto Wajima (HÔZAWA); Rikuzen Enoshima, Onagawa Bay (TANITA).

Localities:—Misaki; Kamakura; Shimoda; Tateyama; Sunosaki; Awa-Kominato.

Remarks:—Judging from the localities of this species above mentioned and from the number of the specimens obtained, this species seems to be very common in the Kantô district.

28. **Leucandra dura** HÔZAWA

(Pl. III, fig. 20)

Leucandra dura, HOZAWA, 1929, p. 371, Pl. XXII., figs. 66–68, text-fig. 33; 1933, p. 15, Pl. I., fig. 7.

There is a single specimen of this species in the collection. It was collected by means of a lobster-net in the neighbourhood of the Shimoda Marine Biological Station and was deposited in the Museum of the same Station.

The sponge forms an amorphous mass with a height of about 15 mm and a breadth of 24 mm. It has a single osculum which is naked and elliptical in form, measuring 5.2 mm in maximum diameter. The dermal surface appears slightly hispid and is harsh to touch. The colour in alcohol is white and the texture is compact and very firm.

Previously known Distributions:— Misaki, off Omae-zaki (HÔZAWA).

Locality: —Nabeta, near Shimoda.

29. **Leucandra foliata** HÔZAWA

(Pl. IV, fig. 21)

Leucandra foliata, HÔZAWA, 1918, p. 547, Pl. 84, fig. 5, text-fig. 9; 1929, p. 370, Pl. XI., fig. 65.

A single specimen in the collection was assigned to this species. It was collected by means of a dredge from a depth of 15–20 fathoms off Futamachiya by Dr. ERI in 1932. The sponge is foliate and is in the form of a shallow cup, attached by a short but stout stalk to some dead shell of a Brachiopod. The height of the specimen is 17 mm. The osculum is an elongated ellipse in shape with a maximum diameter of 20 mm and a minimum of 6 mm. The wall of the sponge is thickest in the middle parts and it becomes gradually thinner towards the oscular margin. The dermal surface is smooth and even. The inner surface, namely the gastral, is also smooth but is minutely punctated. The colour in spirit is white.

Previously known Distributions:— Off Osezaki, Kiushû; off Niijima; Doketsba and Okinose in Sagami Sea (HÔZAWA).

Locality:— Off Futamachiya, 15–20 fathoms.

30. **Leucandra hozawai**, n. sp.

(Pl. IV, fig. 22; Text-fig. 8)

Only one specimen of this new species was collected by Prof. HŌZAWA at Koajiro, near the Misaki Marine Biological Station. It (Pl. IV, fig. 22) is a solitary individual of an oval shape, and is attached to the zoarium of some Bryozoa by its lower side. It measured 11 mm in total length and 8 mm in greatest breadth.

The osculum at the upper end is nearly circular in shape and has not any distinct fringe. It measures about 1 mm in diameter and leads into a deep gastral cavity. The dermal surface of the sponge is hispid due to the projecting large oxea, while the gastral appears nearly smooth to the naked eye.

Colour in alcohol is white and the texture is hard and rather elastic.

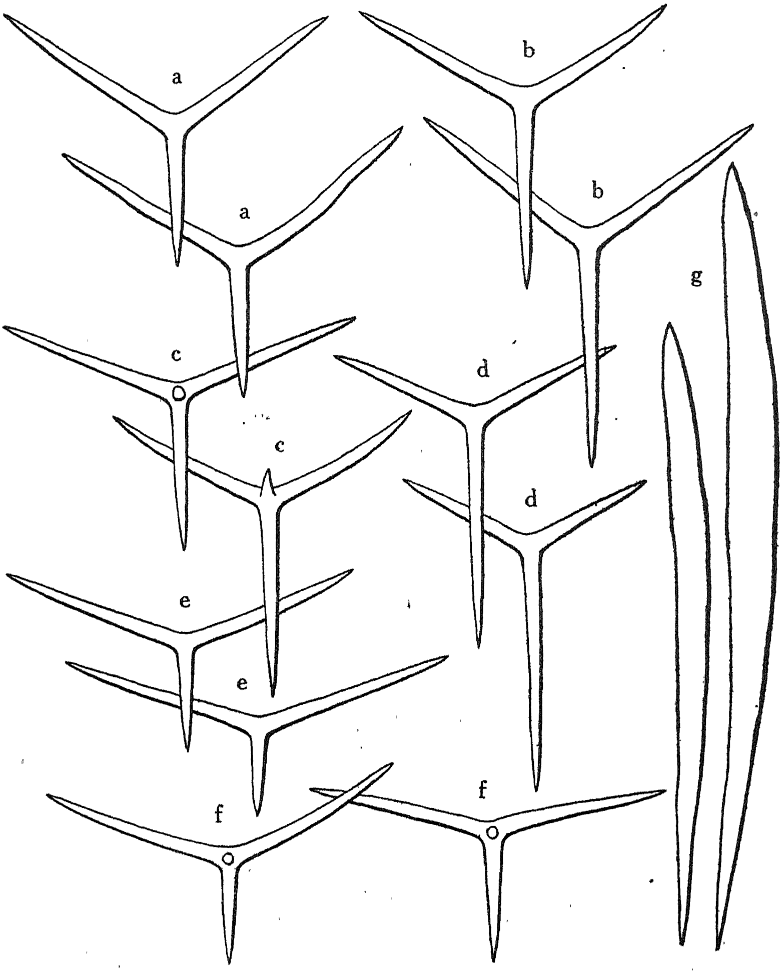
Structures :— The canal system is of the leuconoid type. The flagellate chambers are spherical or oval in shape, and are densely arranged in the chamber layer.

The dermal skeleton is rather thin, consisting mainly of a few layers of tangentially arranged triradiates. In addition to these spicules, large oxea project from the dermal surface. The tubar skeleton is composed of slightly sagittal triradiates which are very numerous and are set together without any definite order, and of basal rays of subgastral triradiates. The walls of the larger exhalant canals are provided with a number of quadriradiates.

The gastral skeleton is as thick as the dermal, being made up of the paired rays of subgastral triradiates and of gastral tri- and quadriradiates. The last two sorts of spicules are placed parallel to the gastral surface and the short apical rays of the gastral quadriradiates project into the gastral cavity. Nearer the osculum the gastral spicules become much more strongly sagittal. The oscular margin is thin and consists externally of the dermal triradiates and large oxea and internally of the spicules the same as those forming the gastral skeleton.

Spicules (Text-fig. 8) :— Dermal triradiates (a) slightly sagittal. Basal ray straight, gradually tapering to a rather sharply pointed end, 80–130 μ long and 10–14 μ thick at base. Paired rays equal, either straight or slightly curved backwards, longer than basal ray, 130–190 μ long and 10–14 μ thick at base.

Tubar triradiates (b) also sagittal. Basal ray straight, sharply pointed, 180–220 μ long and 12–18 μ thick at base. Paired rays equal, nearly



Text-fig. 8. *Leucandra hozawai*, n. sp. a, dermal triradiates; b, tubar triradiates; c, quadriradiates of larger exhalant canal; d, subgastral triradiates; e, gastral triradiates; f, gastral quadriradiates; g, oxea. (all ×120)

straight, 160–250 μ long and 12–18 μ thick at base.

Quadriradiates of the larger exhalant canal (c) are of about the same size and shape as the tubar triradiates with addition of apical ray, which is shorter than the facial rays, nearly straight, about 50 μ long and 12 μ thick at base.

Subgastral triradiates (d) sagittal. Rays are of the same thickness being 14–17 μ. Basal ray straight, longer than paired rays, varies from 180 μ to 290 μ in length. Paired rays straight, more widely divergent than in the case of the tubar triradiates and 130–220 μ long.

Gastral triradiates (e) strongly sagittal. Basal ray straight, much shorter than paired rays, 120–140 μ long and 12 μ thick at base. Paired rays widely divergent, either straight or slightly curved backwards, 220–280 μ long and 12 μ thick at base.

Gastral quadriradiates (f) similar to triradiates of the same, except for the presence of apical ray. Apical ray slightly curved oralwards, sharply pointed, shorter than facial rays, 50–60 μ long and 10–12 μ thick at base.

Triradiates and quadriradiates of the oscular margin are of about the same size as those of the gastral, differing only in wider oral angles.

Large oxea (g) stout, spindle-shaped, slightly curved, rather sharply pointed at both ends, 430–1400 μ long and 40–70 μ thick in the thickest parts.

Locality:— Koajiro, near Misaki.

Remarks:— This species bears a marked resemblance to *Leucandra paucispina* HÔZAWA¹⁾ in external form, but it may be easily distinguished from the latter species by the absence of microxea and subgastral quadriradiates, and moreover by the differences in spiculations.

This specific name was dedicated to Prof. HÔZAWA, who is the collector of the type specimen.

31. **Leucandra impigra**, n. sp.

(Pl. IV, fig. 23; Text-fig. 9)

The collection contains numerous specimens of this new species. They were collected by the writer at Kamakura and Enoshima. The general external appearance of the sponges varies a good deal with respect to the size. In some specimens they are solitary and irregularly massive with an osculum at their upper ends, while the others form a colony of several individuals, all united together at their bases.

The largest specimen which has served as the type of this new species (Pl. IV, fig. 23) is a colony consisting of three individuals and is 10 mm high and 12 mm broad. There is found an osculum at the upper end of each individual. The osculum is nearly circular in shape with a diameter of about 1 mm and has a very feebly developed oscular fringe. The dermal surface is highly hispid owing to the large oxea projecting from it, while the gastral seems to be smooth to the naked eye.

Colour in alcohol is dirty white and the texture is very hard.

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1) *Leucandra paucispina*, HÔZAWA, 1929, p. 356, Pl. IX., figs. 55, 56, text-fig. 28.

Structures :— The canal system is leuconoid. The flagellate chambers are nearly spherical in shape, measuring 60–80 μ in diameter and are densely arranged in the chamber layer.

The dermal skeleton is not well developed, being hardly distinguishable from the tubar skeleton. It consists of triradiates which are tangentially placed in a few layers and of thinly scattered microxea. The large oxea occur here and there and project from the dermal surface.

The skeleton of the chamber layer is mainly composed of numerous triradiates which are densely set together, the basal rays of the subgastral triradiates are also added to the skeleton. The gastral skeleton is made up of paired rays of subgastral triradiates and of tangentially arranged gastral tri- and quadriradiates. The short apical rays of the gastral quadriradiates project into the gastral cavity. The gastral microxea are very numerous, and are densely distributed, lining the entire gastral cavity and the entrances of the larger exhalant canals.

The oscular margin is thin and is the continuation of the dermal and gastral skeleton, thus there are no special oscular spicules to be mentioned except for the spicules having wide divergent oral angles.

Spicules (Text-fig. 9) :— Dermal triradiates (a) slightly sagittal. All rays are of nearly equal thickness. Basal ray straight, rather sharply ended, shorter than paired rays, 85–140 μ long and 14–22 μ thick at base. Paired rays equal, either nearly straight or slightly curved backwards, 90–160 μ long and 14–22 μ thick at base.

Tubar triradiates (b) exactly similar to the dermal triradiates.

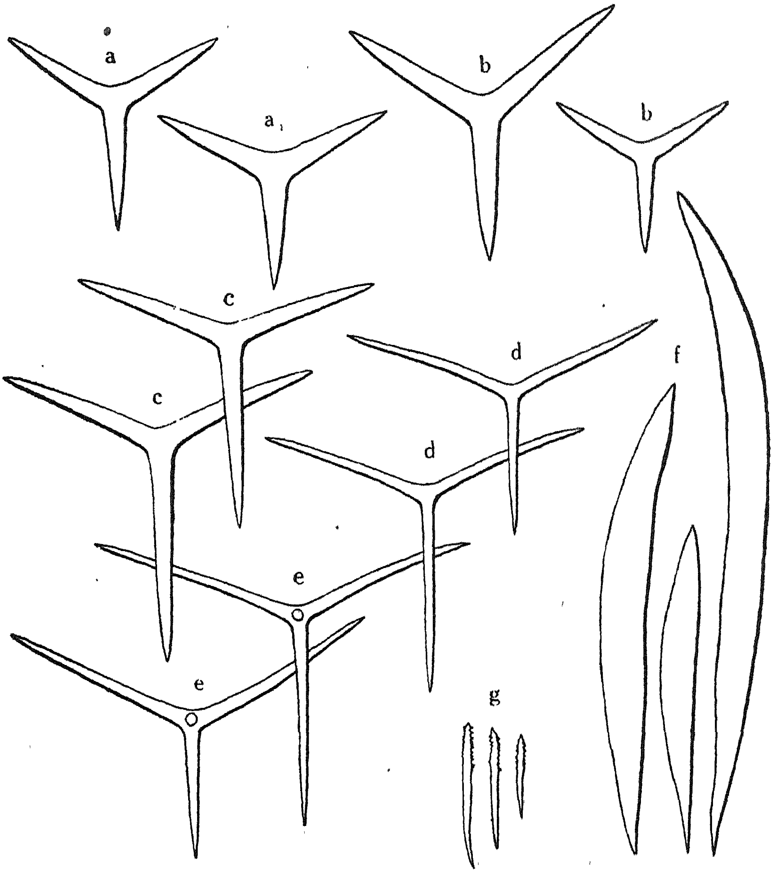
Subgastral triradiates (c) sagittal. Basal ray straight, longer than paired rays, 120–180 μ long and 14–22 μ thick at base. Paired rays widely divergent, slightly curved backwards in basal parts, 100–160 μ long and 14–22 μ thick at base.

Gastral triradiates (d) also sagittal. Basal ray straight, sharply pointed, 150–185 μ long and 10–12 μ thick at base. Paired rays equal, slightly curved backwards, 130–210 μ long and 10–12 μ thick at base.

Gastral quadriradiates (e) exactly similar to the gastral triradiates, except for the presence of short apical ray. Apical ray curved upwards, sharply ended, shorter and thinner than the facial rays, about 40 μ long and 8 μ thick at base.

Large oxea (f) very stout, spindle-shaped, slightly curved, tapering to both ends, varying a good deal in length, 0.8–1.7 mm long and 40–120 μ thick in the thickest parts.

Dermal microxea (g) the same as those of the gastral, either straight



Text-fig. 9. *Leucandra impigra*, n. sp. a, dermal triradiates; b, tubar triradiates; c, subgastral triradiates; d, gastral triradiates; e, gastral quadriradiates; f, large oxea: g, microxea. (a–e ×150, f ×60, g ×240)

or slightly curved being 55–80 μ long and 4–6 μ thick in the middle parts. The one end is provided with many spine-like protuberances arranged on the sides while the other is singly pointed.

Localities:— Kamakura and Enoshima, Province Sagami.

Remarks:— This species is obviously very closely related to *Leucandra abratsbo* Hôzawa[1] which was first described by Hôzawa using a single specimen taken from Misaki. There are, however, certain marked differences in spiculation between these two species. For instance, in the shape and size of gastral radiates and of microxea, and especially in the presence in the present species of the gastral microxea, which are entirely wanting in *L. abratsbo*.

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[1] *Leucandra abratsbo*, Hôzawa, 1929, p. 359, Pl. 9, figs. 57, 58, text-fig. 29.

32. Leucandra magna, n. sp.

(Pl. IV, fig. 24; Text-fig. 10)

This new species is represented in the collection by a single specimen. It was obtained by Dr. Eri off Daibusa, in Bôsyû, from a depth of 100–200 fathoms.

The sponge is a solitary person of an elongated cylindrical form, being bent near the base which is attached to a foreign object. The osculum at the upper end is oval in shape with a maximum diameter of 5 mm and appears to be naked. The total length of the body is 50 mm, the greatest breadth is about 13 mm and the body wall is about 1.5 mm thick in the middle parts. The dermal surface is slightly hispid due to the projecting oxea but that of the gastral is smooth. The gastral cavity is very large and extends through the entire length of the sponge body.

The colour in alcohol is nearly white and the texture is moderately firm.

Structures :— The canal system is of the leuconoid type. The flagellate chambers are ovoid or spherical, with a diameter of 80–140 μ.

The dermal skeleton is composed of several layers of sagittal triradiates which lie parallel to the dermal surface. Their basal rays are pointed more or less downwards. The large oxea which occur here and there in nearly vertical disposition in the sponge wall, project outwards on the dermal surface to some extent. The hair-like spicules are rather scarce and lie at nearly right angles to the dermal surface.

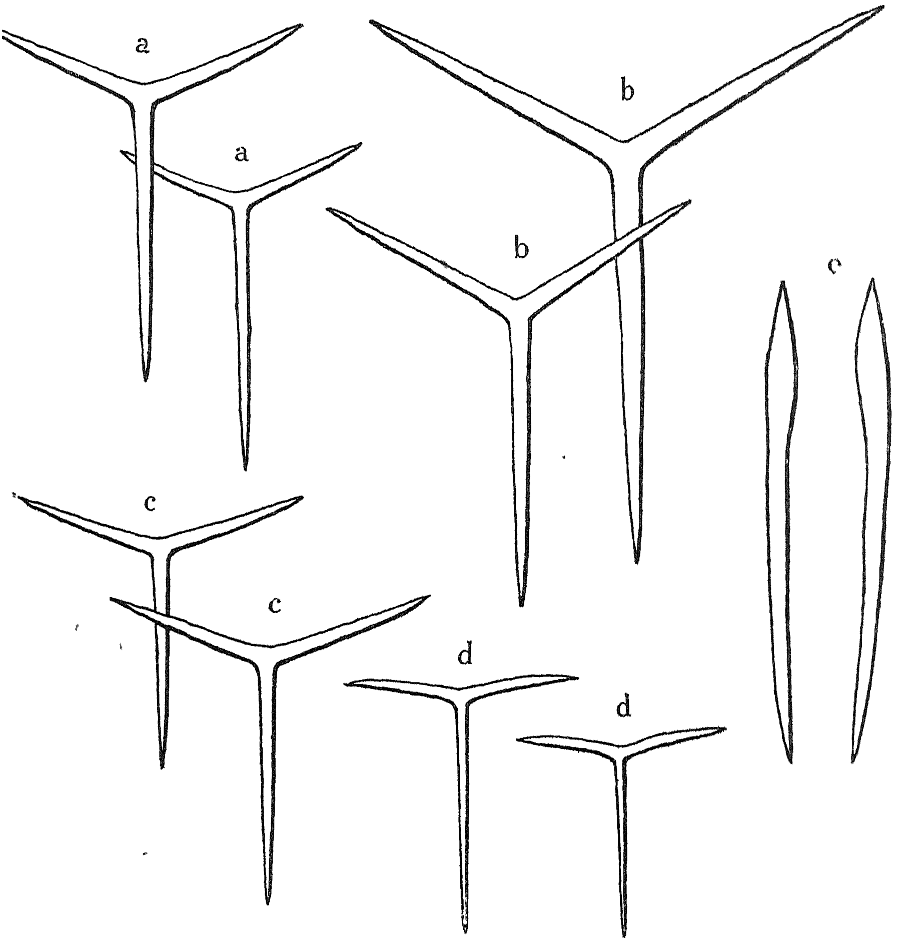
The tubar skeleton is made up of triradiates only. They are scattered in the chamber layers.

The gastral skeleton is thinner than the dermal, consisting of triradiates placed tangentially in two or three layers. Most of their basal rays are directed towards the sponge base.

The oscular margin is very thin but without any fringe and consists of triradiates and a few linear spicules. The basal rays of the former kind of spicules run parallel with the latter.

Spicules (Text-fig. 10) :— Dermal triradiates (a) sagittal. All rays nearly equally thick and gradually sharply pointed. Basal ray straight, longer than paired rays, 410–490 μ long and 12–20 μ thick at base. Paired rays slightly curved forwards, 230–310 μ long and 12–20 μ thick at base.

Tubar triradiates (b) slightly sagittal but three angles being nearly equal. Basal ray straight, sharply pointed, longer than paired rays, 300–720 μ long and 25–50 μ thick at base. Paired rays nearly equal, straight,



Text-fig. 10. *Leucandra magna*, n. sp. a, dermal triradiates; b, tubar triradiates; c, gastral triradiates; d, triradiates of oscular margin; e, oxea. (all ×80)

260–470 μ long and 25–50 μ thick at base.

Gastral triradiates (c) sagittal. Basal ray straight, longer than paired rays, 270–350 μ long and 14–20 μ thick at base. Paired rays equal, slightly curved forwards, 200–310 μ long and 14–20 μ thick at base.

Triradiates of the oscular margin (d) strongly sagittal. Basal ray straight, longer and thinner than paired rays, 320–400 μ long and about 8 μ thick at base. Paired rays equal, widely divergent, 150–240 μ long and 10–12 μ thick at base.

Oxea (e) slightly curved, sharply pointed at both ends. The distal end of oxea is provided with a feebly developed lance-head while the proximal is solely sharply pointed. It measures 700 μ–1 mm in length and 40–55 μ in thickness in the thickest parts.

Hair-like oxea slender, nearly uniformly thick with both ends sharply pointed. The free ends are usually found broken off. An example of the spicules measured 900 μ long and 3 μ thick.

Locality :— Bôsyû Daibusa, 100–200 fathoms.

Remarks :— This species seems to be closely related to *Leucandra pulvinar* (HAECKEL)[1] and to *L. kurilensis* HÔZAWA[2], but is readily distinguished from both species by its external features and by the shape of oxea and of other spicules. This new species may be easily distinguished from other members of the same genus by the absence of quadriradiates.

33. **Leucandra mitsukurii** HÔZAWA

Leucandra mitsukurii, HÔZAWA, 1929, p. 350, p. 8, figs. 50–52, text-fig. 26.

This species is represented by two specimens in the collection. They were obtained by Prof. HÔZAWA from Shimoda in 1933. The larger specimen is nearly oval in form and is provided with a circular osculum of 1 mm diameter directed towards one side of the body. The sponge measures 8 mm in height, 6 mm in breadth, and 4 mm in thickness. The dermal surface is hispid owing to the projecting oxea, while the gastral appears nearly smooth to the naked eye. The body wall is 2 mm thick in the thickest parts.

The smaller one has a form somewhat irregularly massive with the height of about 6 mm.

The colour of the both specimens is white and the texture is hard.

Previously known Distribution:— Misaki (HÔZAWA).

Locality :— Shimoda.

34. **Leucandra multituba** HÔZAWA

(Pl. IV, fig. 25)

Leucandra multituba, HÔZAWA, 1929, p. 365, Pl. X., figs. 61, 62, text-fig. 31.

Twelve specimens of this species were obtained from the three different localities of Misaki, Shimoda, and Awa-Kominato. They are either solitary or colonial, composed of several individuals united together at their bases.

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[1] *Leucortis pulvinar*, HAECKEL, 1872, p. 162, Taf. 29.

[2] *Leucandra kurilensis*, HÔZAWA. 1918, p. 549, Pl. 85, fig. 11, text-fig. 10.

The largest specimen (Pl. IV, fig 25) is a solitary one in the form of slightly laterally compressed ovoid, provided with an osculum at the upper end. It measures 31 mm in total length and 20 mm in greatest breadth. The osculum which is surrounded by a well-developed collar is nearly circular in shape with a diameter of 3 mm. The dermal surface is hispid from the projecting oxea.

The colour of the specimens in alcohol varies from nearly white to dark-gray. The texture is very firm.

Previously known Distribution:— Misaki (HOZAWA).

Localities:— Misaki; Shimoda; Awa-Kominato.

35. **Leucandra nakamurai**, n. sp.

(Pl. IV, fig. 26; Text-fig. 11)

This new species is represented in the collection by five specimens. They were secured by the writer from the two different localities of Awa-Kominato and in the neighbourhood of the Mitsui Institute of Marine Biology, near Shimoda. Each of them forms a solitary individual with an osculum at the upper end. The writer has selected the largest specimen taken from Shimoda and shown in Pl. IV, fig. 26 on which to base the following descriptions.

The sponge represents an irregularly curved and laterally compressed massive body provided with a naked osculum 1 × 1.8 mm wide. It was found attached to a sea-weed. It measures 10 mm in height, 7.5 mm in greatest breadth, and about 4 mm in the maximum thickness. The dermal surface of the sponge is not even and appears slightly hispid due to the projecting oxea. To the naked eye the hispidity of the gastral was not recognized.

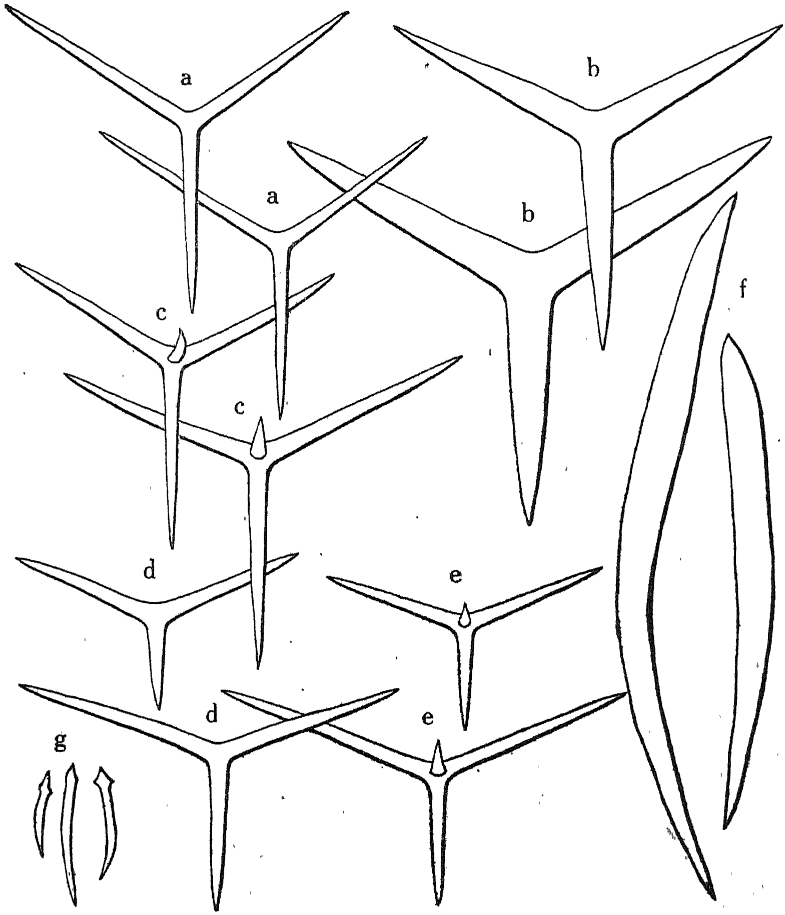
The colour in alcohol is yellowish-white and the texture is rigid.

Structures:— The canal system is of the leuconoid type. The flagellate chambers are circular or oval in cross-section, with a diameter of 60 95 μ and are densely packed in the chamber layer. The dermal skeleton is made up of triradiates, large oxea, and microxea. The triradiates are arranged tangentially and are set in a few layers without any definite orientation. The large oxea are in sparse distribution, and each of these projects to some extent from the dermal surface. The microxea which are found in scattered distribution, project nearly vertically from the surface.

The skeleton of the chamber layer is composed of stout triradiates which are densely and irregularly set together in the layer. The wall of the larger exhalant canals are lined with quadriradiates with their apical rays projecting into the canals. The gastral skeleton is as thick as the dermal consisting of gastral tri- and quadriradiates. They are placed tangentially in a few layers and the short apical rays of the gastral quadriradiates project into the gastral cavity.

Spicules (Text-fig. 11):—Dermal triradiates (a) regular. Rays equally thick, sharply pointed, 170–350 μ long and 16–30 μ thick at base.

Tubar triradiates (b) also regular, distinctly stouter than the dermal. Rays stout, tapering to rather sharp end, even in outline, 180–350 μ long and 30–60 μ thick at base.



Text-fig. 11. *Leucandra nakamurai*, n. sp. a, dermal triradiates; b, tubar triradiates; c. quadriradiates of larger exhalant canal; d, gastral triradiates; e, gastral quadriradiates; f, large oxea; g, microxea. (a–f ×100, g ×200)

Quadriradiates of the larger exhalant canals (c) regular or subregular with a short apical ray. The facial rays equal in length and in thickness, straight, sharply pointed, 230–330 μ long and 18–25 μ thick at base. Apical ray short, slightly curved, sharply ended, 55–95 μ long and 20 μ thick at base.

Gastral triradiates (d) sagittal. Basal ray straight, tapering to sharply pointed end, shorter than paired rays, 120–220 μ long and 15–20 μ thick at base. Paired rays equal, either straight or slightly curved, widely divergent, 190–280 μ long and 15–20 μ thick at base.

Gastral quadriradiates (e) similar to the gastral triradiates except for the presence of short apical ray. Apical ray slightly curved, sharply pointed, shorter and thinner than facial rays, 35–60 μ long and 15 μ thick at base.

Large oxea (f) stout, spindle-shaped, usually curved, tapering to both ends, 500–850 μ long and 45–60 μ thick at the thickest portion.

Dermal microxea (g) slightly curved, sharply pointed at one end, while the other forms a lance-head. They measure 60–90 μ long and 4–6 μ thick at the head.

Localities:— Awa-Kominato; Shimoda.

Remarks:— In external form the present species bears a marked resemblance to *Leucandra spissa* (URBAN)[1], while in the spiculation it approaches *L. rigida* HÔZAWA[2]. URBAN's species, however, differs from the present species in spiculation, especially in the shape of microxea and of gastral quadriradiates. *L. rigida* differs from the present species not only in external form, but also in the presence of microxea in both the dermal and gastral skeloton. I have dedicated this species to the late Dr. NAKAMURA who rendered the writer courteous help during his stay at the Kominato Marine Biological Station and who died shortly after that time.

36. Leucandra pacifica HÔZAWA

(Pl. IV, fig. 27)

Leucandra pacifica, HÔZAWA, 1929, p. 368, Pl. X., figs. 63, 64, text-fig. 32.

The collection contains four specimens of this species. The first specimen was collected from a depth of about 70 fathoms off Mikomoto, Province Izu, and the second was secured from Misaki, while the remaining two were obtained from a depth of 100–200 fathoms off Shimasita.

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[1] *Leuconia spissa*, URBAN, 1908, p. 21, Taf. IV., figs. 1–26.

[2] *Leucandra rigida*, HÔZAWA, 1940, p. 44, Pl. IV., fig. 3, text-fig. 5.

They vary in size and shape. The largest specimen (Pl. IV, fig. 27) which came from Shimasita consists of a single tubular individual with massive lower portion. It is about 30 mm high and about 15 mm broad in the broadest parts. The osculum at the upper end is naked and is elliptical in shape, measuring about 4 mm by 2.5 mm. The dermal surface is uneven and is harsh to touch.

The specimen which came from Mikomoto is not a perfect one, having the lower portion torn off.

The specimen from Misaki is the smallest and is sac-like in form, measuring 12 mm in height.

Previously known Distribution:—Doketsba, in Sagami Sea (HÔZAWA).

Localities:— Off Mikomoto; Shimasita; Misaki.

37. **Leucandra sola**, n. sp.

(Pl. IV, fig. 28; Text-fig. 12)

This new species is based upon a single specimen preserved in the Museum of the Shimoda Marine Biological Station. It (Pl. IV, fig. 28) is a solitary cylindrical individual with a height of 13.5 mm and a maximum diameter of 4 mm. The osculum at the upper end of the body is nearly circular in shape with a diameter of 2 mm and is surrounded by a feebly developed collar. It leads into a deep and narrow gastral cavity extending throughout the entire length of the sponge. The body wall measures about 1.3 mm in thickness in the middle parts of body. The dermal surface is slightly hispid and the gastral is equally hispid.

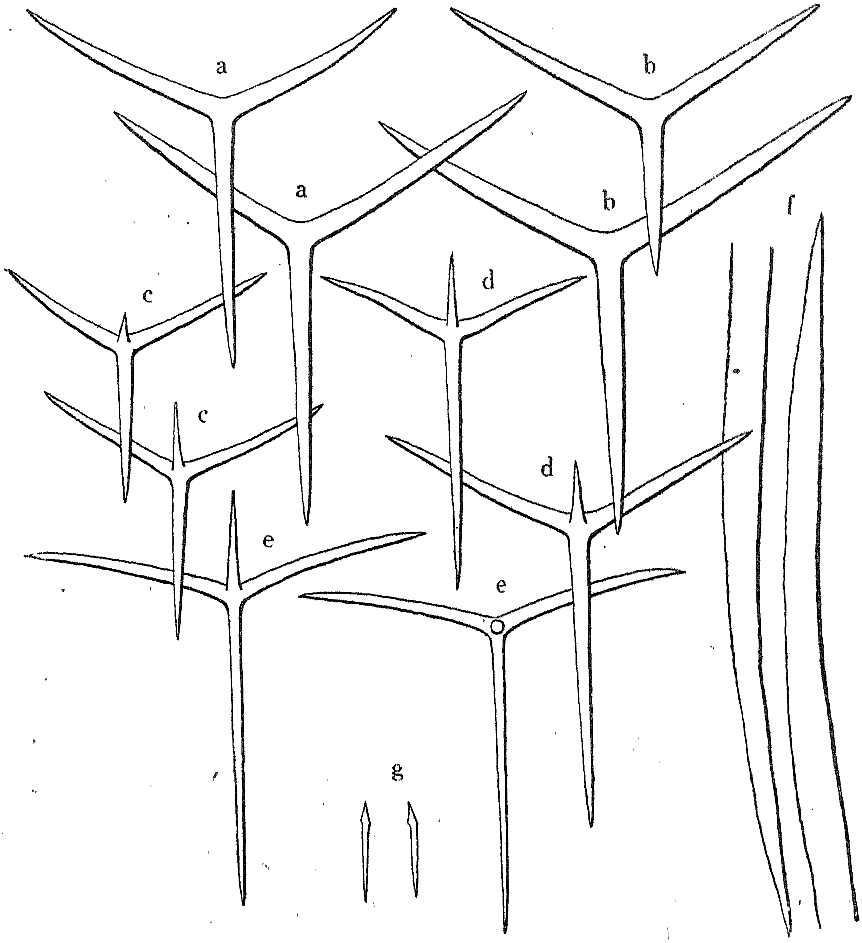
The colour of the sponge in a preserved state is white and the texture is hard and brittle.

Structures:— Owing to the bad state of preservation, it is difficult to make out any details concerning the canal system, but is seems to be of the leuconoid type.

The dermal skeleton is very thin being composed of tangentially placed triradiates, and the microxea thinly covers the dermal surface, each of which stand at various angles to the dermal surface. The tubar skeleton is made up of triradiates which are variable in size and are thickly and irregularly set together. The walls of the larger exhalant canals are lined with quadriradiates with apical rays projecting into the canal.

The gastral skeleton is thicker than the dermal and may be distinguished fairly well from that of the chamber layer. It consists of several layers of quadriradiates which have long apical rays and downwardly directed basal rays. The oscular margin is composed of linear spicules and of quadriradiates placed densely and provided with strongly divergent paired rays.

Spicules (Text-fig. 12) :—Dermal triradiates (a) subregular or slightly sagittal. Basal ray straight, sharply pointed, 300–380 μ long and 20–25 μ thick at base. Paired rays equal, either straight or very slightly curved forwards, 290–360 μ long and 20–25 μ thick at base.



Text-fig. 12. *Leucandra sola*, n. sp. a, dermal triradiates; b, tubar triradiates; c, quadriradiates of larger exhalant canal; d, gastral quadriradiates; e, quadriradiates of oscular margin; f, large oxea; g, dermal microxea. (a–f ×100, g ×200)

Tubar triradiates (b) nearly similar to the dermal triradiates, but variable in size. Basal ray straight, tapering to sharp end, 270–410 μ long and 17–25 μ thick at base. Paired rays 285–360 μ long and 17–25 μ thick at base.

Quadriradiates of the larger exhalant canals (c) have facial rays slightly sagittal. Basal ray straight, slightly longer than paired rays, 170–230 μ long and 10–15 μ thick at base. Paired rays curved forwards, 160–210 μ long and 10–15 μ thick at base. Apical ray slightly curved, sharply pointed, shorter and thinner than facial rays, 70–100 μ long and 8–10 μ thick at base.

Gastral quadriradiates (d) strongly sagittal. Basal ray straight, much longer than paired rays, 230–350 μ long and 10–20 μ thick at base. Paired rays equal, either straight or slightly curved, 180–230 μ long and 10–20 μ thick at base. Apical ray sharply pointed, variable in length, thinner than facial rays, 160–350 μ long and 8–12 μ thick at base.

Quadriradiates of oscular margin (e) strongly sagittal. Basal ray straight, longer and thinner than paired rays, 250–330 μ long and 8–10 μ thick at base. Paired rays equal, widely divergent, curved backwards, 190–250 μ long and 10–14 μ thick at base. Apical ray slightly curved oralwards, sharply pointed, 180–200 μ long and about 8 μ thick at base.

Large oxea (f) slightly curved, not even in outline, sharply pointed at both ends, measuring up to 1.5 mm in length and about 45 μ thick in the middle parts.

Microxea (g) nearly straight, sharply pointed at both ends, but one of which forms a lance-head, 60–80 μ long and 3–5 μ thick in the thickest parts.

Locality :— Shimoda.

Remarks :— This species bears a marked resemblance to *Leucandra vitrea* (URBAN)[1] in external form, while in spiculation it approaches to *L. abratsbo* HÔZAWA[2]. But URBAN's species differs from the present species in spiculation. This species may be easily distinguished from *L. abratsbo* not only by the external appearance but also by the absence of gastral triradiates and by other details.

38. **Leucandra tuberculata** HÔZAWA

(Pl. IV, fig. 29)

Leucandra tuberculata, HÔZAWA, 1929, p. 432, Pl. 8, figs. 44, 45, text-fig. 23.

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[1] *Leuconia vitrea*, URBAN, 1908, p. 37, Taf. VI., figs. 20–38.

[2] *Leucandra abratsbo*, HÔZAWA, 1929, p. 359, Pl. 9, figs. 57, 58, text-fig. 29.

This species is represented by three small specimens. One of them was collected by Prof. HÔZAWA in 1933 in the neighbourhood of the Shimoda Marine Biological Station and the remaining two were secured by the writer from Sunosaki, Province Awa.

The largest specimen (Pl. IV, fig. 29) which came from Shimoda, consists of a solitary individual of sac-like shape, somewhat irregularly curved and provided with an osculum at the upper end. The sponge is about 9 mm long and 5.8 mm in greatest breadth. The osculum is elliptical with the greatest diameter of 1.3 mm.

Previously known Distribution:— Koajiro, near Misaki (HÔZAWA).

Localities:— Shimoda; Awa-Sunosaki.

Remarks:— This species was first described by HÔZAWA (1929). The present paper, therefore, makes known the occurrence of this species in Japanese waters for the second time. The dermal skeleton of this species is extremely thick, and as HÔZAWA noticed in his original description, it occupies 1/5–1/3 of the entire thickness of the body wall. This species may be easily distinguished from other species of the genus by this characteristic and by other as well.

39. **Leucandra valida** LAMBE

Leucandra valida, LAMBE, 1900, p. 32, Pl. 4, fig. 10, Pl. 5, fig. 11; DENDY and ROW, 1913, p. 771; TANITA, 1941, p. 275, Pl. 8, fig. 9, text-fig. 3.

Seven specimens of this species are contained in the collection. They were collected by the writer from Sunosaki and Shimoda. Each of them represents a solitary individual of a subcylindrical form, showing an osculum which is surrounded by a well-developed collar at the upper end. The largest specimen measures about 8 mm in height and 5 mm in greatest breadth. The colour in alcohol varies from nearly white to grey.

Previously known Distributions:— Davis Strait, Exetor Harbour (LAMBE); Onagawa Bay, off Rikuzen Izushima (TANITA).

Localities:— Bôsyû Sunosaki; Shimoda.

V. Family **Amphoriscidae** DENDY

Genus **Leucilla** HAECKEL

40. **Leucilla hirsuta**, n. sp.

(Pl. IV, fig. 30; Text-fig. 13)

This new species is represented by two specimens in the collection.

They were collected by the writer from the shore of Awa-Kominato.

The larger specimen (Pl. IV, fig. 30) which is herewith made the type of the species, is a solitary individual of elongate cylindrical form, more or less curved and laterally compressed, being broadest at the lower parts. The total length is 8 mm and the greatest breadth is about 3 mm. The osculum at the upper end is nearly circular, with a diameter of 1 mm and is surrounded by a well-developed oscular collar. The dermal surface is hispid due to the projecting oxea and the gastral is also rough from the projecting apical rays of the gastral quadriradiates.

The colour in alcohol is white and the texture is firm.

Structures :— The canal system is of the leuconoid type. The flagellate chambers are thickly packed among the well-developed inhalant and exhalant canals and are nearly spherical in form, measuring 50–80 μ across.

The dermal skeleton is composed of : 1) the tangentially placed triradiates; 2) the facial rays of subdermal quadriradiates, arranged parallel to the dermal triradiates; 3) large oxea occuring here and there in the sponge wall, with their distal ends projecting from the dermal surface at nearly right angles; and 4) the rather densely distributed microxea.

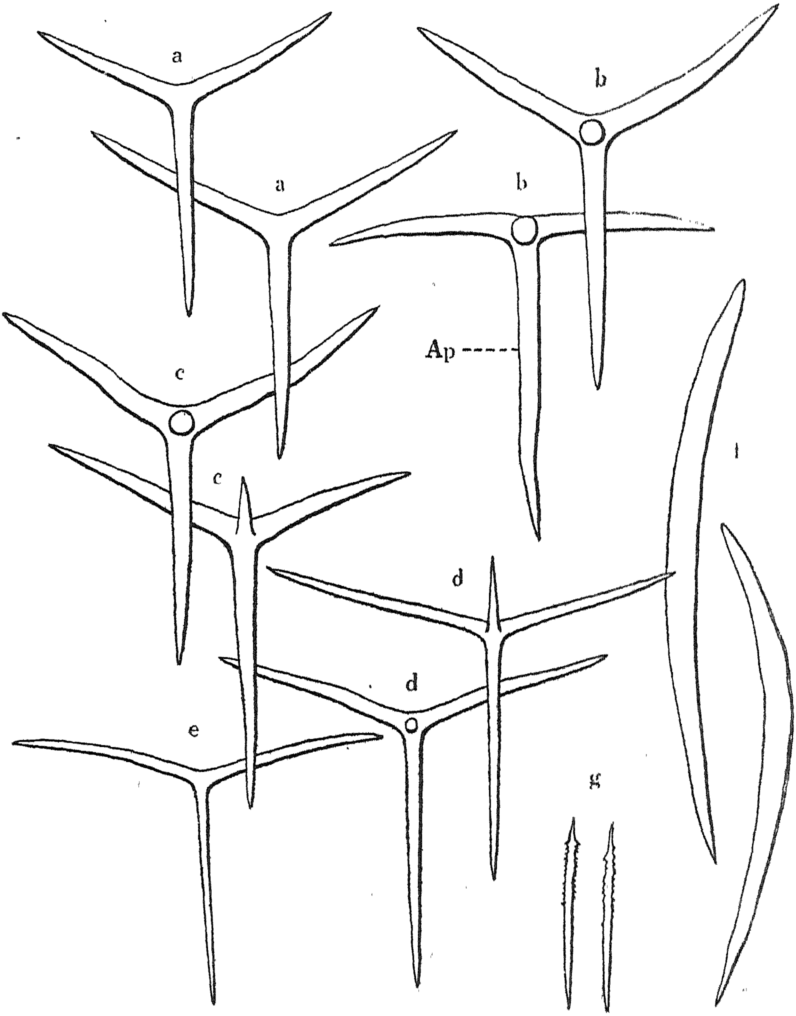
The tubar skeleton is made up of the apical rays of subdermal quadriradiates and of a few confused layers of tubar quadriradiates. The gastral skeleton is mainly consisted of slender quadriradiates with apical rays projecting into the gastral cavity. The facial rays of subgastral quadriradiates may be also added to the same skeleton.

The skeleton of the oscular margin is composed of the triradiates with basal rays directed downwards and of the longitudinally arranged linear spicules forming an oscular collar.

Spicules (Text-fig. 13) :— Dermal triradiates (a) slightly sagittal. All rays are nearly the same thickness of 15–22 μ. Basal ray straight, tapering to sharp end, slightly longer than paired rays being 180–220 μ in length. Paired rays nearly equal, slightly curved forwards and 160–210 μ long.

Subdermal quadriradiates (b) also slightly sagittal. Basal ray straight, sharply pointed, 210–260 μ long and 15–25 μ thick at base. Paired rays equal, slightly curved forwards, 180–220 μ long and 15–25 μ thick at base. Apical ray straight or slightly curved, sharply pointed, nearly equal to or longer than facial rays, 180–260 μ long and 12–23 μ thick at base.

Tubar quadriradiates (c) nearly similar to the subdermal quadriradiates in shape, but are slightly smaller and thinner than the latter. Basal ray is 180–230 μ long and 14–22 μ thick; paired rays are 120–250 μ long and



Text-fig. 13. *Leucilla hirsuta*, n. sp. a, dermal triradiates; b, subdermal quadriradiates; c, tubar quadriradiates; d, gastral quadriradiates; e, triradiate of oscular margin; f, large oxea; g, dermal microxea. Ap....Apical ray. (a–f ×150, g ×240)

14–22 μ thick, and the apical ray measures in length of 120–170 μ.

Subgastral quadriradiates nearly similar the tubar quadriradiates except for the wider oral angles.

Gastral quadriradiates (d) sagittal with rays slender. Basal ray straight, sharply pointed, slightly longer than paired rays, 220–260 μ long and about 10 μ thick at base. Paired rays equal, slightly curved forwards, 170–240 μ

long and 10 μ thick at base. Apical ray sharply pointed, curved oralwards, shorter than facial rays, 120–210 μ long and 7–10 μ thick at base.

Triradiates of the oscular margin (e) sagittal. Basal ray straight, thinner than paired rays, about 210 μ long and 6–8 μ thick at base. Paired rays equal, widely divergent, curved backwards, about 200 μ long and 10 μ thick at base.

Large oxea (f) elongate spindle-shaped, usually curved, sharply pointed at both ends, 480–850 μ long and 28–40 μ thick in the thickest parts.

Microxea (g) nearly straight, sharply pointed at both ends. The inner end is solely pointed while the outer is provided with a lance-head. The distal half of this kind of spicules is beset with fine spines on its sides. Microxea measure 85–130 μ in length and is 3–6 μ thick measured at the thickest parts.

Linear spicules at the oscular margin straight, nearly uniformly thick in the greater part of their length. An example of the spicules measured about 1.2 mm long and 5 μ thick.

Locality:— Awa-Kominato.

Remarks:— The present species belongs without doubt to the genus *Leucilla*, but can not be identified with any previously known species. The most conspicuous feature of this species exists in the presence of both large oxea and microxea. DENDY and ROW⁽¹⁾ have grouped the members of the genus into three sections, namely: A) without oxea; B) with large radially arranged oxea or trichoxea, but without microxea; and C) without large oxea, but with microxea. Thus it seems to be rather reasonable to add the fourth section D, with large oxea and microxea, and in this section this new species may be included.

LITERATURE CITED

ARNESEN, E. (1901). Spongier fra den norske kyst. I. Calcarea. Systematisk katalog med bemerkninger og bestemmelsestabel. Bergens Mus. Aarbog, No. 5.

BOWERBANK, J. S. (1864–1882). A Monograph of the British Spongiadae. Ray Soc., London, 4 Vols.

BREITFUSS, L. (1) (1897). Catalog der Calcarea der zoologischen Sammlung des königlichen Museums für Naturkunde zu Berlin. Arch. für Naturgesch., Jahrgang LXIII, Bd. 1, pp. 205–226.

—— (2) (1898). Kalkschwammfauna des weissen Meeres und der Eismeerküsten des europäischen Russlands mit Berücksichtigung und Aufstellung der Kalkschwammfauna der arktischen Region. Mémoires d el'Acad. Imp. des Science, St. Péterbourg, (ser. 8) Vol. VI, No. 2.

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(1) DENDY and ROW, 1913, Proc. Zool. Soc. London, p. 783.

—— (3) (1898). Die arctische Kalkschwammfauna. Inaugural-Dissertation zur Erlangung der Doctorwürde von der Pilos. Fak. Univ. Zürich, pp. 1–40.

—— (4) (1898). Kalkschwammfauna der Westküste Portugals. Zool. Jahrb., Syst. Abth., Bd. XI, pp. 89–102.

—— (5) (1898). Die Kalkschwämme der Sammlung Plate (Fauna Chilensis, Bd. I) Zool. Jahrb. Suppl., Bd. IV, pp. 455–470.

—— (6) (1927). Die Kalkschwammfauna der Nord- und Ostsee. Zool Anz., Bd. LXX, pp. 26–36.

—— (7) (1932). Die Kalkschwammfauna des arktischen Gebietes. Fauna arctica, pp. 237–252.

—— (8) (1936). Kalkschwämme vom Skagerrak und Kattegat unter Berücksichtigung ihrer Weltverbreitung. Göteborgs Kungl. Vetenskops och Vitterhets Samhälles Handlinger Femte Följden, Ser. B, Bd. 4, No. 15.

Brøndstedt, H. V. (1) (1923). Sponges from the Auckland and Campell Islands. Papers from Dr. Th. Mortensen's Pacific Expedition 1914–16 XV. Vidensk. Medd. fra Bansk Naturh. Foren., Bd. 75.

—— (2) (1926). Sponge from New Zealand. Part II. Paper from Dr. Th. Mortensen's Pacific Expedition 1914–16 XXXV. Vidensk. Medd. fra Dansk Naturh. Foren., Bd. 81, pp. 295–331.

Burton, M. (1933). Report on a small Collection of Spongs from Stil Bay, S. Africa. Ann. Mag. Nat. Hist., Ser. 10, Vol. LL, p. 235.

Burton, M. and Rao, H. S. (1932). Report on the Shallow-water Marine Sponges in the Collection of the Indian Museum. Rec. Indian Mus., Vol. XXXIV, Part III, pp. 299–356, Pl. 18.

Carter, H. J. (1) (1871). On two underscribed Sponges and two Esperiadae from the West Indies; also on the nomenclature of the Calcisponge *Clathrina*, Gray. Ann. Mag. Nat. Hist., ser. 4, Vol. VII, pp. 268–283.

—— (2) (1877). Arctic and Antarctic Sponges. Ann. Mag. Nat. Hist., ser. 4, Vol. XX, pp. 38–42.

—— (3) (1885–1886). Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia. Ann. Mag. Nat. Hist., ser. 5, Vol. XVII, pp. 431–441; 502–516; Vol. XVIII, pp. 34–55; 126–149.

Dendy, A. (1) (1891). A Monograph of the Victorian Sponges. Part I. The Organisation and Classification of the Calcarea Homocoela, with descriptions of the Victorian Species. Trans. Roy. Soc. Victoria, Vol. 3, No. 1, pp. 1–82, Pls. I–IX.

—— (2) (1892). Synopsis of the Australian Calcarea Heterocoela, with a proposed Classification of the Group, and Descriptions of some New Genera and Species. Proc. Roy. Soc. Victoria (N. S.) Vol. 5, pp. 69–116.

—— (3) (1893). Studies on the Comparative Anatomy of Sponges. V. Observations on the Structure and Classification of the Calcarea Heterocoela, Quart. Journ. Microsc. Sci., (N. S.) Vol. XXXV, pp. 159–257.

—— (4) (1905). Report on the Sponges collected by Prof. Herdman at Ceylon in 1902. Rep. Pearl Oyster Fish. Gulf Manaar, Vol. 3, pp. 59–246, Pls. I–XVI.

—— (5) (1913). Report on the Calcareous Sponges collected by the Sealark Expedition in the Indian Ocean. Trans. Linnean Soc. London, Zool., Vol. 16, pp. 1–29, Pls. I–IV.

Dendy, A. and Frederick, L. M. (1924). On a Collection of Sponges from the Abrolhos Islands, Western Australia. Journ. Linn. Soc. London, Zool., Vol. XXXV, pp.

477–518, Pls. 25, 26.

DENDY, A. and ROW, R. W. H. (1913). The Classification and Phylogeny of the Calcareous Sponges, with a Reference List of all the described Species, systematically arranged. Proc. Zool. Soc. London, 1931, pp. 704–813.

DÖDERLEIN, L. (1892). Description of *Petrostroma schulzei*, ng. et. sp. of Calcarea, representing a new order Lithones. Verhandl. deutsch. Zool. Ges., Vol. 2, pp. 143–145.

GRAY, J. E. (1867). Notes on the Arrangement of Sponges, with descriptions of some new Genera. Proc. Zool. Soc. London, 1867, pp. 492–558, Pls. 27, 28.

HAECKEL, E. (1872). Die Kalkschwämme, eine Monographie. Berlin.

HANITSCH, R. (1) (1890). Third Report on the Porifera of the L. M. B. C. District. Proc. Liverpool Biol. Soc., Vol. 4, pp. 192–238, Pls. X–XV.

—— (2) (1895). Notes on a Collection of Sponges from West Coast of Portugal. Trans. Liverpool Biol. Soc., Vol. 9, pp. 205–219, Pls. 12, 13.

HARA, J. (1894). On a new Species of Calcareous Sponge, *Lelapia nipponica*. Zool. Mag. Tokyo, Vol. VI, pp. 359–370, Pl. 8.

HÔZAWA, S. (1) (1916). On some Japanese Calcareous Sponges belonging to the Family Heteropiidae. Journ. Coll. Sci. Imp. Univ. Tokyo, Vol. 38, Art 5, Pls. I, II.

—— (2) (1918). Report on the Calcareous Sponges collected by the U. S. Fisheries Steamer "Albatross" in the North Western Pacific during 1906. Proc. U. S. Nat. Mus., Vol. 54, pp. 525–556, Pls. 84, 85.

—— (3) (1928). Report of the Biological Survey of Mutsu Bay. 6. Calcarea of Mutsu Bay. Sci. Rep. Tohoku Imp. Univ. Biol., Vol 3, pp. 219–221, Pl. I.

—— (4) (1929). Studies on the Calcareous Sponges of Japan. Journ. Fac. Sci. Imp. Univ. Tokyo, Sec. IV, Zool., Vol I, Part 5, pp. 277–389, Pls. I–XII.

—— (5) (1933). Report on the Calcareous Sponges obtained by the Survey of the Continental Shelf bordering on Japan. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 8, pp. 1–20, Pl. I.

—— (6) (1940). On Some Calcareous Sponges from Japan. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 15, No. 1, pp. 29–58, Pls. 4, 5.

—— (7) (1940). Report on the Calcareous Sponges obtained by the Zoological Institute and Museum of Hamburg. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 15, No. 2, pp. 131–163, Pls. 6, 7.

JOHNSTON, G. (1842). A History of British Sponges and Lithophytes. Edinburgh.

KIRK, H. B. (1895). New Zealand Sponges. Third Paper. Trans. New Zealand Inst., Vol. 28, pp. 205–210, Pls. 3, 4.

LAMBE, L. M. (1900). Sponges from the Coasts of North-eastern Canada and Greenland. Trans. Roy. Soc. Canada ser. 2, Vol. 6, sect. 4, pp. 19–48, Pls. I–VI.

LENDENFELD, R. (1) (1885). The Homocoela of Australia and the new Family Homodermidae. Proc. Linn. Soc. New South Wales, Vol. 9, pp. 896–907.

—— (2) (1885). A Monograph of the Australian Sponges. Part III. The Calcispongiae. Proc. Linn. Soc. New South Wales, Vol. 9, pp. 1083–1150, Pls. LIX–LXVII.

LIEBERKÜHN, N. (1859). Neue Beiträge zur Anatomie der Spongien. Müller's Archiv, 1859, pp. 353–382; 515–530.

MINCHIN, E. A. (1896). Suggestions for a Natural Classification of the Asconoidae. Ann. Mag. Nat. Hist. ser. 6, Vol. 18, pp. 349–362.

MONTAGU, G. (1812). An Essay on Sponges, with Descriptions of all the Species that have been discovered on the Coast of Great Britain. Mem. Wern. Soc. Edinburgh, Vol. 2, pp. 67–122.

Ridley, S. O. (1881). Spongida eollected during the Fxpedition of H. M. S. Alert in the Straits of Magellan and on the Coasts of Patagonia. Proc. Zool. Soc. London, 1881, pp. 107–137, Pls. 10, 11.

Row, R. W. H. (1909). Reports on the Marine Biology of the Sudanese Red Sea. XIX. Report on the Sponges collected by Mr. Cyril Crossland in 1904–1905. Part I. Calcarea. Journ. Linn. Soc. London, Zool., Vol. 31, pp. 182–214, Pls. 19, 20.

Row, R. W. H. and Hôzawa, S. (1931). Report on the Calcarea obtained by the Hamburg South-West Australian Expedition of 1905. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 6, No. 4, pp. 727–809, Pls. 19–21.

Tanita, S. (1) (1940). Calcareous Sponges of Matsushima Bay. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 15, No. 2, pp. 165–177, Pl. 8.

—— (2) (1941). Report of the Biological Survey of Mutsu Bay. 35. Studies on the Calcarea of Mutsu Bay. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 16, No. 1, pp. 1–8, Pl. 1.

—— (3) (1941). Calcareous Sponges obtained from Onagawa Bay and its Vicinity. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 16, No. 3, pp. 263–282, Pl. 17.

Thacker, A. G. (1908). On Collections of the Cape Verde Islands Fauna made by Cyril Crossland, M. A., from July to September 1904. The Calcareous Sponges. Proc. Zool. Soc. London, pp. 757–782, Pl. XL.

Topsent, E. (1936). Etude sur des *Leucosolenia.* Bull. L'Institut Océano. No. 711, pp. 1–47.

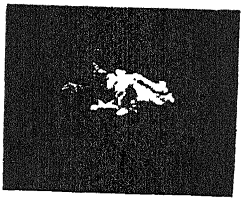
Urban, F. (1) (1908). Die Kalkschwämme der deutschen Tiefsee-Expedition. Zool. Anz., Bd. XXXIII, pp. 247–252.

—— (2) (1909). Die Calcarea. Wiss. Ergeb. deutschen Tiefsee-Exped. (Valdivia), Bd. XIX, Jena.

EXPLANATION OF THE PLATES

PLATE II

Fig. 1. *Leucosolenia izuensis*, n. sp. ×2.
Fig. 2. *Leucosolenia mutsu* Hôzawa. ×2.
Fig. 3. *Leucosolenia protogenes* (Haeckel) ×2.
Fig. 4. *Leucosolenia serica*, n. sp. ×2.
Fig. 5. *Leucosolenia stipitata* Dendy ×2.
Fig. 6. *Sycon album*, n, sp. ×2.
Fig. 7. *Sycon cylindricum*, n, sp. ×2.
Fig. 8. *Sycon luteolum*, n. sp. ×2.
Fig. 9. *Sycon misakiensis* Hôzawa ×2.
Fig. 10. *Grantessa intusarticulata* (Carter) ×2.
Fig. 11. *Grantessa mitsukurii* Hôzawa. Natural size.
Fig. 12. *Grantessa parva*, n. sp. ×2.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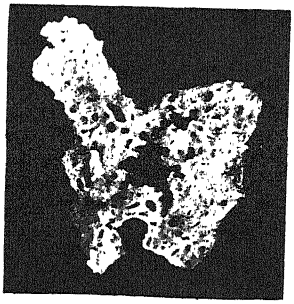
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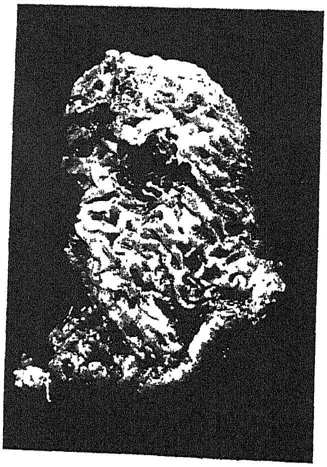
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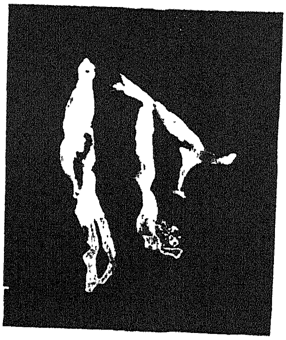
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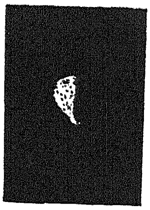
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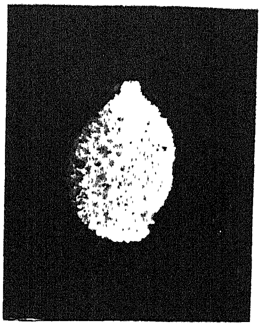
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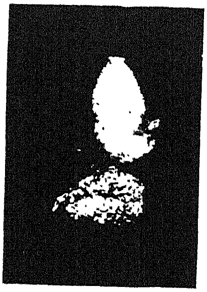
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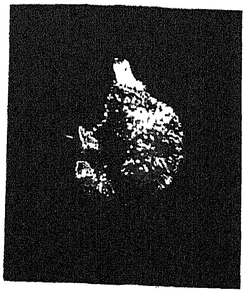
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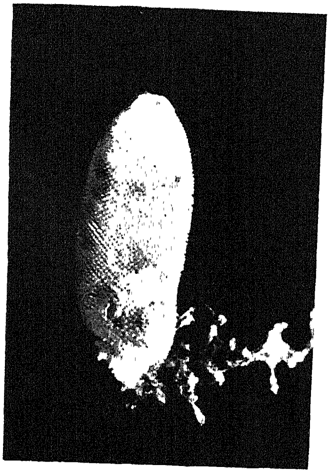
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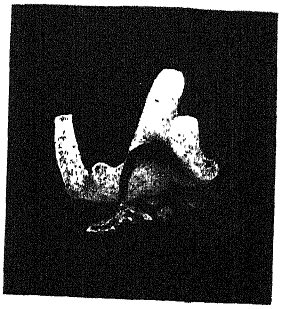
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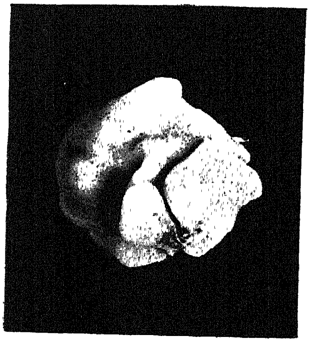
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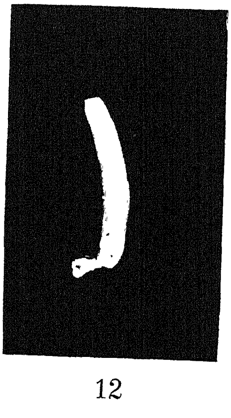
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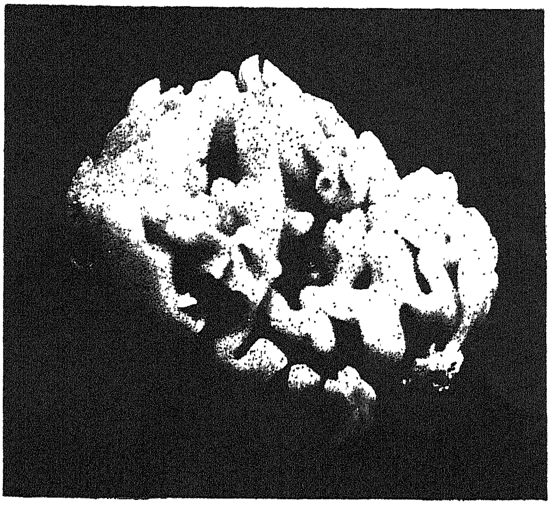
Tanita photo.

S. Tanita: Calcarea of Kantô District.



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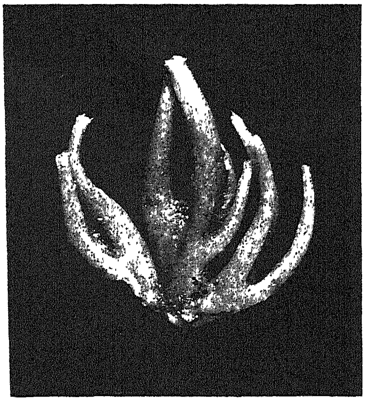

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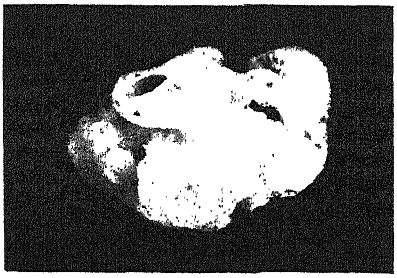

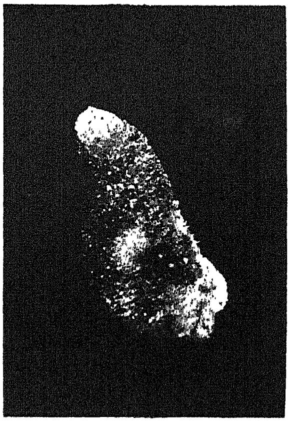

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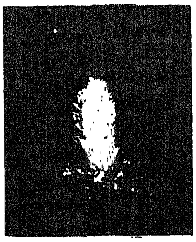

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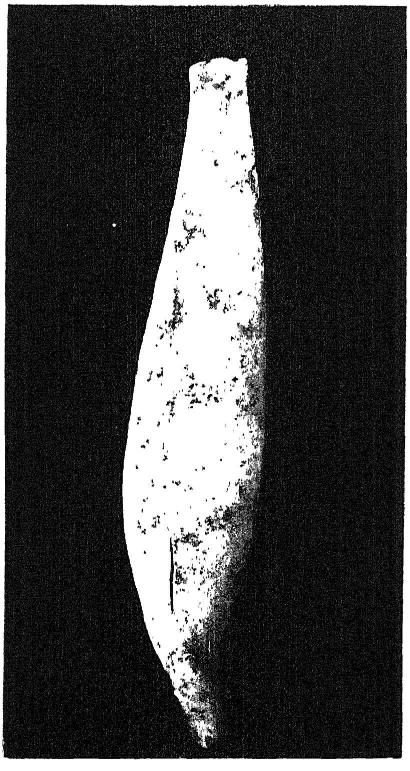

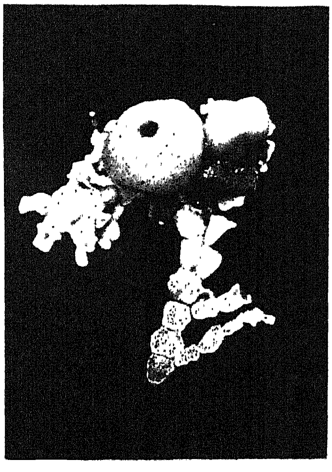

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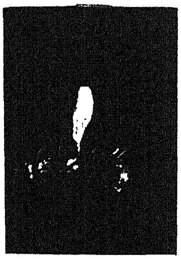

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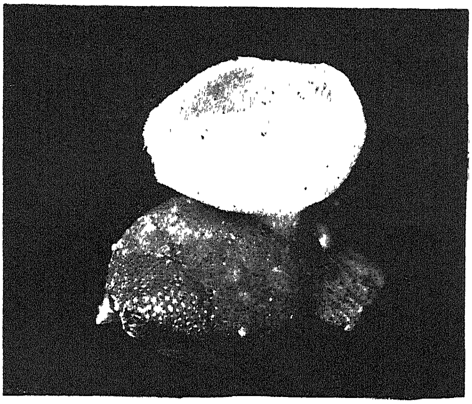
Tanita photo.

S. Tanita: Calcarea of Kantô District.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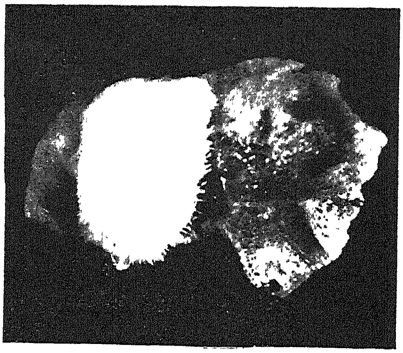

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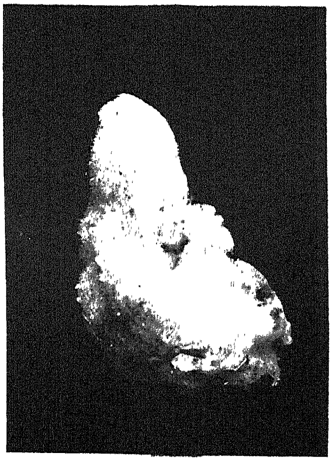

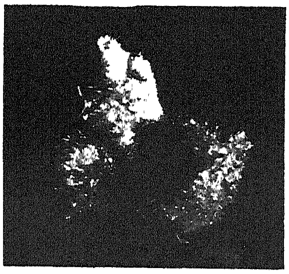
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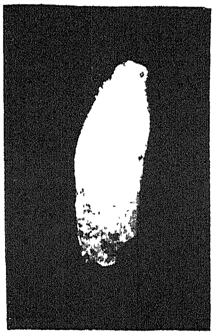
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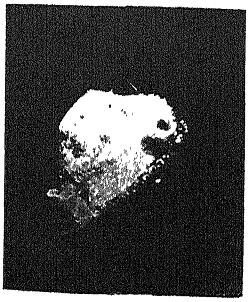
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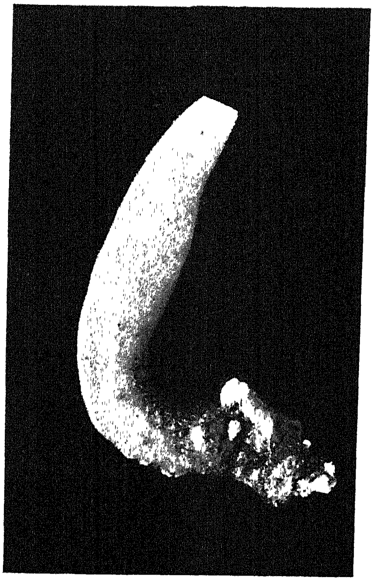

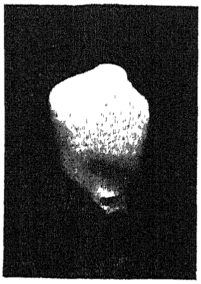
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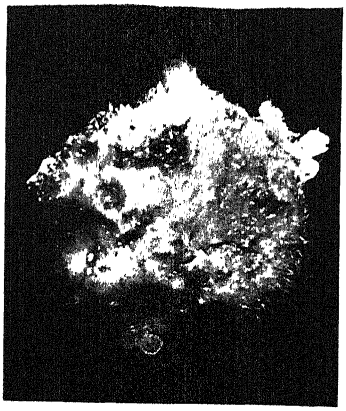

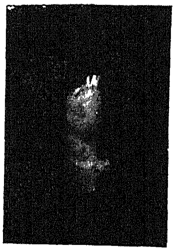
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TANITA photo.

S. TANITA: Calcarea of Kantô District.

PLATE III

Fig. 13. *Grantessa shimeji* Hôzawa ×1.5.
Fig. 14. *Grantessa shimoda*, n. sp. ×2.
Fig. 15. *Heteropia striata* Hôzawa ×1.5.
Fig. 16. *Amphiute ijimai* Hôzawa. Natural size.
Fig. 17. *Vosmaeropsis japonica* Hôzawa ×1.5.
Fig. 18. *Vosmaeropsis maculata* Hôzawa ×2.
Fig. 19. *Ute pedunculata* Hôzawa ×2.
Fig. 20. *Leucandra dura* Hôzawa ×1.5.

PLATE IV

Fig. 21. *Leucandra foliata* Hôzawa ×1.5.
Fig. 22. *Leucandra hozawai*, n. sp. ×2.
Fig. 23. *Leucandra impigra*, n. sp. ×2.
Fig. 24. *Leucandra magna*, n. sp. Natural size.
Fig. 25. *Leucandra multituba* Hôzawa ×2.
Fig. 26. *Leucandra nakamurai*, n. sp. ×2.
Fig. 27. *Leucandra pacifica* Hôzawa ×1.5.
Fig. 28. *Leucandra sola*, n. sp. ×2.
Fig. 29. *Leucandra tuberculata* Hôzawa ×2.
Fig. 30. *Leucilla hirsuta*, n. sp. ×2.

KEY TO ALL THE DESCRIBED SPECIES OF THE GENUS *LEUCOSOLENIA* AND THEIR DISTRIBUTION

By

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(Received October 20, 1941)

Since the time that BOWERBANK erected the genus *Leucosolenia* in 1866, a number of investigators have worked on the same group of calcareous sponges and thus many species have been described. The number of species hitherto recorded is estimated to be over one hundred.

In 1872, HAECKEL proposed a so-called "Natural system" dealing with the classification of calcareous sponges. In this system he has divided *Calcarea* into three families of *Ascones*, *Leucones*, and *Sycones*, basing the distinguishing characteristics mainly upon the type of canal system. Within these families he has distinguished twenty one genera, taking into consideration the natures of spicules they bear, together with the type of canal system above mentioned.

This system of classification was seemingly convenient in identifying the species. However, it has not been accepted by most of the later writers, as it was thought to be too artificial. In HAECKEL's system, the genus *Leucosolenia* was placed in the family of *Ascones*.

In 1891, DENDY divided the genus *Leucosolenia* into three sections of *Simplicia*, *Reticulata*, and *Radiata*, according to the form of the sponge body and to the feature of the canal system.

In 1913, DENDY and ROW published a list of all the described species of *Calcarea* arranged systematically. In this paper they have grouped the members of *Leucosolenia* into two sections by the presence or absence of oxea.

It seems to be almost impossible in the present day to prepare a complete key to the members belonging to such a large genus as *Leucosolenia*, as it is nearly impossible to examine all of the type specimens which are scattered in various parts of the world.

Now I should like to propose a key to all of the known species belonging to the genus *Leucosolenia*, hoping it can be practically used in future studies. The key, mentioned later, was prepared in most cases from the descriptions published, except for some species reported from Japanese waters. As a matter of practical convenience, I have selected the types and formes of spicules as the main features in distinguishing the species. At first, according to the presence or absence of oxea, the genus was divided into two sections as DENDY and ROW have done. And then three groups were distinguished within each section, according to the types of spicules they have.

With regard to the spicules, three main forms are seen amongst the *Calcarea :* 1), the triradiate spicules which are by far the commonest and are looked upon as the most primitive form in the case of *Calcarea ;* 2), the quadriradiate spicules; and 3), the oxeote spicules. Of the triradiate spicules, HAECKEL distinguished three groups, namely, regular, sagittal, and irregular. When the three angles and the three rays of a spicule are equal, it is said to be regular. And when the two angles and two rays set in pairs are equal, the spicule is said to be sagittal. In the case of an irregular triradiate, all of the three rays are unequal in length and all of the three angles are unlike. As in the case of the triradiates, the quadriradiates may also be classified in three types of regular, sagittal, and irregular. In most cases the rays of the spicules are straight and are generally sharply pointed at their extremities. But they may frequently become more or less curved, and sometimes their extremities are blunt or spined.

Key to the Genus Leucosolenia

SECTION A. WITHOUT OXEA

Group I. With Triradiates only

Divison 1. Spicules regular

Subdivision a) Spicules 2 kinds (Dermal large, deep small)

1. L. osculum (CARTER)
   Clathrina osculum, CARTER (1885–1886) p. 503.
   Leucosolenia osculum, DENDY (1891) p. 69; DENDY and ROW (1913) p. 726.
2. L. poterium (HEACKEL)
   Ascetta primordialis var. *poterium,* HAECKEL (1872) p. 16, Pl. 1, 2; Pl. 5, fig. 1
   Clathrina poterium, RIDLEY (1881) p. 133.
   Leucosolenia poterium, POLÉJAEFF (1883) p. 35, Pl. 3, figs. 1, 2; BREITFUSS (1897)

p. 212; (1898) p. 457, Pl. 27, fig. 1; (1932) p. 242; Dendy and Row (1913) p. 726.

Ascetta poterium, Lendenfeld (1885) p. 898; (1885) p. 1084.

Ascetta conulata, Lendenfeld. fide Breitfuss (1897).

3. L. proxima Dendy

Leucosolenia proxima, Dendy (1891) p. 62, Pl. 2, figs. 1, 2; Pl. 8, figs. 1-4; Pl. 11, fig. 2; Kirk (1895) p. 207; Dendy and Row (1913) p. 727.

4. L. wilsoni Dendy

Leucosolenia wilsoni, Dendy (1891) p. 63, Pl. 2, figs. 3, 4; Pl. 7; Pl. 11, fig. 3; Dendy and Row (1913) p. 727; Tanita, (1942) p. 27.

Subdivision b) Spicules 1 kind, rays sharply pointed.

5. L. dictyoides Haeckel

Leucosolenia dictyoides, Haeckel (1870) p. 243; Lackschewitz (1886) p. 299; Breitfuss (1897) p. 211; (1898) p. 458, Pl. 27, fig. 2; (1932) p. 241; (1935) p. 10; Dendy and Row (1913) p. 725.

Ascetta primordialis var. *dictyoides*, Haeckel (1872) p. 16, Pl. 1, 2; Pl. 5, fig. 1.

Ascetta dictyoides, Lendenfeld (1885) p. 1084.

6. L. loculosa (Haeckel)

Soleniscus loculosus, Haeckel (1870) p. 244.

Clathrina loculosa, Haeckel (1870) p. 245.

Auloplegma loculosum, Haeckel (1870) p. 250.

Thecometra loculosa, Haeckel (1870) p. 254.

Ascetta primordialis var. *loculosa*, Haeckel (1872) p. 16, Pl. 1, 2; Pl. 5, fig. 1.

Ascetta loculosa, Lendenfeld (1885) p. 1085.

Leucosolenia loculosa, Dendy and Row (1913) p. 726; Breitfuss (1932) p. 242.

7. L. mutsu Hôzawa

Leucosolenia mutsu, Hôzawa (1928) p. 219, Pl. 1, figs. 1-3; (1940) p. 35; Tanita (1940) p. 165, Pl. 8, fig. 1; (1941) p. 267; (1942) p. 23, Pl. 2, fig. 2.

8. L. primordialis (Haeckel)

Prosycum primordiale, Haeckel (1870) *p*. 237.

Olynthus simplex, Haeckel (1870) p. 237.

Ascetta primordialis, Haeckel (1872) p. 16, Pl, 1, 2; Pl. 5, fig. 1; Lendenfeld (1885) p. 897; (1891) p. 195, Pl. 8, fig. 1; Pl. 9, figs. 23-26; Arnesen (1900) p. 12.

Clathrina primordialis, Carter (1886) p. 510; Minchin (1896) p. 359; Jenkin (1908) p. 6; (1908) p. 436; Row (1909) p. 184.

Leucosolenia primordialis, Lackschewitz (1886) p. 299; Breitfuss (1897) p. 212; (1898) p. 12; p. 21; p. 91; (1932) p. 242; (1935) p. 12; Dendy and Row (1913) p. 726; Hernandez (1918) p. 10; Burton (1926) p. 71; Brøndsted (1928) p. 9, text-fig. 1.

9. L. protogenes (Haeckel)

Ascetta primordialis var. *protogenes*, Haeckel (1872) p. 16, Pl. 1, 2; Pl. 5, fig. 1.

Ascetta procumbens, Lendenfeld (1885) *p*. 1086.

Clathrina primordialis, Carter (1886) p. 510.

Leucosolenia protogenes, Dendy (1891) p. 58, Pl. 3, fig. 1; Pl. 11, fig. 1; Breitfuss (1897) p. 213; (1932) p. 243; (1935) p. 13; Dendy and Row (1913) p. 726; Dendy and Frederick (1924) p. 480, Pl. 25, fig. 2; Brøndsted (1926) p. 297; Tanita (1942) p. 24, Pl. 2, fig. 3.

Subdivision c) Spicules 1 kind, rays bluntly ended

10. L. clathrus (O. Schmidt)

Grantia clathrus, O. Schmidt (1862) p. 24, Pl. 3, fig. 3.

Clathrina sulphurea, Gray (1867) p. 557; Haeckel (1870) p. 245.

Tarrus labyrinthus, Haeckel (1870) p. 244.

Ascetta clathrus, Haeckel (1872) p. 30, Pl. 4, 5, fig. 3; Lendenfeld (1891) p. 210, Pl. 8, fig. 4; Pl. 9, figs. 27–37.

Leucosolenia clathrus, Kirk (1895) p. 206; Breitfuss (1897) p. 211; (1935) p. 9; Lackschewitz (1886) p. 299; Dendy and Row (1913) p. 725; Hernandez (1918) p. 9, fig. 1; Topsent (1936) p. 7, fig. 3.

11. L. coriacea (Montagu)

Spongia coriacea, Montagu (1812) p. 116.

Grantia coriacea, Johnston (1842) p. 183, Pl. 21, fig. 9.

Leucosolenia coriacea, Bowerbank (1866) p. 34; Gray (1867) p. 556; Carter (1877) p. 42; Hanitsch (1895) p. 206; Breitfuss (1897) p. 211; (1898) p. 12; p. 20; p. 91; (1927) p. 28; (1932) p. 241; (1935) p. 7; (1936) p. 6; Dendy (1905) p. 226, Pl. 13, fig. 8; Lundbeck (1909) p. 457; Row (1909) p. 184; Dendy and Row (1913) p. 725; Hernandez (1918) p. 9; Burton (1926) p. 71; (1929) p. 402; (1930) p. 2; (1933) p. 235; Arndt (1928) p. 18, fig. 6; Row and Hôzawa (1931) p. 735; Burton and Rao (1932) p. 303; Topsent (1936) p. 2, figs. 1, 2; Tanita (1942) p. 20.

Clathrina sulphurea, Carter (1871) p. 279.

Clathrina coriacea, Ridley (1881) p. 132; Minchin (1896) p. 359; Jenkin (1908) p. 6.

Ascetta coriacea, Haeckel (1872) p. 24, Pl. 3, 5, fig. 2; Fristedt (1887) p. 405, Pl. 22, figs. 1, 2; Hanitsch (1890) p. 232; Arnesen (1900) p. 10.

12. L. himantia (Johnston)

Grantia botryoides var. *himantia*, Johnston (1842) p. 183, Pl. 21, fig. 9.

Ascetta coriacea var. *himantia*, Haeckel (1872) p. 24, Pl. 3, 5, fig. 2.

Leucosolenia himantia, Dendy and Row (1913) p. 726; Breitfuss (1932) p. 241.

13. L. psammophila Row and Hôzawa

Leucosolenia psammophila, Row and Hôzawa (1931) p. 736, Pl. 19, fig. 1.

Subdivision d) Spicules 1 kind, ends of rays spined

14. L. sceptrum (Haeckel)

Ascetta sceptrum, Haeckel (1872) p. 37, Pl. 5, fig. 4.

Leucosolenia sceptrum, Dendy and Row (1913) p. 727; Hernandez (1918) p. 11.

Division 2. Spicules sagittal

15. L. macleayi (LENDENFELD)
Ascetta macleayi, LENDENFELD (1885) p. 1086, figs. 7-13.
Leucosolenia macleayi, DENDY and ROW (1913) p. 726; BURTON (1930) p. 2; p. 32; (1932) p. 258; (1934) p. 4; BREITFUSS (1932) p. 242; LAUBENFELS (1932) p. 6, fig. 2.

16. L. pedunculata (LENDENFELD)
Leucopsis pedunculata, LENDENFELD (1885) p. 1089, fig. 34.
Leucosolenia pedunculata, DENDY and ROW (1913) p. 726.

17. L. phillipina (HAECKEL)
Ascetta blanca var. *phillipina*, HAECKEL (1872) p. 38, Pl. 5, fig. 5.
Leucosolenia phillipina, DENDY and ROW (1913) p. 726; BREITFUSS (1932) p. 242.

18. L. sagittaria (HAECKEL)
Ascetta sagittaria, HAECKEL (1872) p. 42, Pl. 5, fig. 7.
Leucosolenia sagittaria, BREITFUSS (1898) p. 21; (1927) p. 28; (1932) p. 243; DENDY and ROW (1913) p. 727; ARNDT (1928) p. 18, figs. 7, 8.

19. L. stipitata DENDY
Leucosolenia stipitata, DENDY (1891) p. 51, Pl. 1, figs. 4-6; Pl. 4, fig. 2; Pl. 9, fig. 5; DENDY and ROW (1913) p. 727; ROW and HÔZAWA (1931) p. 739.

20. L. ventosa HÔZAWA
Leucosolenia ventosa, HÔZAWA (1940) p. 31, Pl. 4, fig. 1, text-fig. 1.

21. L. vesicula (HAECKEL)
Clistolynthus vesicula, HAECKEL (1870) p. 248.
Ascetta vesicula, HAECKEL (1872) p. 41, Pl. 5, fig. 6.
Leucosolenia vesicula, DENDY and ROW (1913) p. 727.

Division 3. Spicules irregular

22. L. flexilis (HAECKEL)
Ascetta flexilis, HAECKEL (1872) p. 43, Pl. 5, fig. 8.
Leucosolenia flexilis, DENDY and ROW (1913) p. 725.

Division 4. Spicules regular and sagittal

23. L. blanca (MICHLUCHO-MACLAY)
Guancha blanca, MICHLUCHO-MACLAY (1868) p. 221, Pl. 4, 5; HAECKEL (1870) p. 254.
Olynthus guancha, HAECKEL (1870) p. 237.
Leucosolenia guancha, HAECKEL (1870) p. 243.
Tarrus guancha, HAECKEL (1870) p. 244.
Nardoa guancha, HAECKEL (1870) p. 247.
Ascetta blanca, HAECKEL (1872) p. 38, Pl. 5, fig. 5; LENDENFELD (1891) p. 218, Pl. 8, fig. 5; ARNESEN (1900) p. 9.

Leucosolenia blanca, Poléjaeff (1883) p. 37, Pl. 1, fig. 2; Pl. 3, fig. 3; Lackschewitz (1886) p. 300; Vosmaer (1887) p. 370; Breitfuss (1896) p. 1; (1897) p. 210; (1898) p. 13; p. 19; p. 105; (1932) p. 240; (1935) p. 7; (1936) p. 5; Dendy and Row (1913) p. 724; Arndt (1928) p. 19, figs. 9, 10; Brøndsted (1928) p. 12, text-figs. 7, 8; Hôzawa (1929) p. 282; Topsent (1936) p. 9, figs. 4, 5.

Clathrina blanca, Minchin (1896) p. 359; Jenkin (1908) p. 438, figs. 85-87.

24. L. challengeri Poléjaeff

Leucosolenia challengeri, Poléjaeff (1883) p. 38, Pl. 1, fig. 1; Pl. 3, fig. 4; Kirk (1895) p. 207; Dendy and Row (1913) p. 724.

Ascetta challengeri, Lendenfeld (1885) p. 899; p. 1085.

Division 5. With tripod spicules

Subdivision a) With tripod and regular spicules

25. L. clathrata (Carter)

Leucetta clathrata, Carter (1883) p. 33, Pl. 1, figs. 13-17.

Clathrina tripodifera var. *gravida*, Carter (1885-1886) p. 507.

Leucosolenia tripodifera var. *gravida*, Dendy (1891) p. 68.

Leucosolenia intermedia, Kirk (1895) p. 208, Pl. 4, fig. 2; Brøndsted (1926) p. 298.

Leucosolenia clathrata, Dendy and Row (1913) p. 724; Row and Hôzawa (1931) p. 730; Hôzawa (1940) p. 30.

Subdivision b) With tripod and sagittal spicules

26. L. pulcherrima Dendy

Leucosolenia pulcherrima, Dendy (1891) p. 52, Pl. 1, fig. 7; Pl. 4, fig. 3; Pl. 10, fig. 3; Dendy and Row (1913) p. 727.

Group II. With Quadriradiates only

Division 6. Spicules regular

27. L. convallaria (Haeckel)

Ascilla gracilis var. *convallaria*, Haeckel (1872) p. 45, Pl. 6, figs. 1-7.

Leucosolenia convallaria, Dendy and Row (1913) p. 725.

28. L. gracilis (Haeckel)

Ascilla gracilis, Haeckel (1872) p. 44, Pl. 6, figs. 1-7.

Leucosolenia gracilis, Breitfuss (1897) p. 211; Dendy and Row (1913) p. 725.

29. L. spinosa (Lendenfeld)

Ascetta spinosa, Lendenfeld (1891) p. 203, Pl. 8, figs. 2, 16, 21, 22.

Leucosolenia spinosa, Breitfuss (1897) p. 213; (1935) p. 15; Dendy and Row (1913) p. 727.

Division 7. Spicules sagittal

30. L. japonica (Haeckel)

Ascilla japonica, Haeckel (1872) p. 47, Pl. 6, figs. 8, 9.
Leucosolenia japonica, Dendy and Row (1913) p. 726; Hôzawa (1929) p. 285.

31. L. kagoshimensis Hôzawa

Leucosolenia kagoshimensis, Hôzawa (1929) p. 285, Pl. 1, figs. 6, 7, text-fig. 3.

Group III. With Triradiates and Quadriradiates

Division 8. Spicules regular

Subdivision a) Triradiates equal to quadriradiates

32. L. canariensis (Michlucho-Maclay)

Nardoa canariensis, Michlucho-Maclay (1868) p. 230.
Nardoa sulphurea, Michlucho-Maclay (1868) p. 230.
Nardoa rubra, Michlucho-Maclay (1868) p. 230.
Torroma canariensis, Haeckel (1870) p. 244.
Torroma rubrum, Haeckel (1870) p. 245.
Ascaltis canariensis, Haeckel (1872) p. 52, Pl. 9, figs. 1–3; Pl. 10, fig. 1.
Ascaltis compacta, Schuffner (1877) p. 404, Pl. 25, fig. 9.
Leucosolenia nanseni, Breitfuss (1896) p. 427; (1898) p. 13; p. 106, Pl. 12, figs. 1–9; (1932) p. 242; Lundbeck (1909) p. 458.
Leucosolenia canariensis, Lackschewitz (1886) p. 300, Pl. 7, fig. 1; Thacker (1908) p. 762, Pl. 40, fig. 3, text-figs. 157–160; Dendy and Row (1913) p. 724; Hôzawa (1918) p. 528; (1933) p. 2, Pl. 1, fig. 1; (1940) p. 134, Pl. 6, fig. 2, texf-fig. 2; Breitfuss (1932) p. 240; Tanita (1941) p. 264, Pl. 17, fig. 1.

33. L. cancellata Verrill

Leucosolenia cancellata, Verrill (1874) p. 393; Lambe (1896) p. 203, Pl. 3, fig. 5; (1900) p. 27, Pl. 2, fig. 5; p. 165; Dendy and Row (1913) p. 724; Breitfuss (1932) p. 240.

34. L. cerebrum (Haeckel)

Ascaltis cerebrum, Haeckel (1872) p. 54, Pl. 8, 10, fig. 2.
Ascetta cerebrum, Lendenfeld (1891) p. 206, Pl. 8, fig. 3; Pl. 9, figs. 38–44.
Leucosolenia cerebrum, Kirk (1895) p. 207; Breitfuss (1897) p. 210; (1935) p. 8; Dendy and Row (1913) p. 724; Burton (1933) p. 236; Topsent (1936) p. 17, figs. 8, 9.

35. L. caroli (Haeckel)

Ascaltis darwinii var. *caroli*, Haeckel (1872) p. 57, Pl. 9, fig. 4; Pl. 10, fig. 3.
Leucosolenia caroli, Dendy and Row (1913) p. 724.

36. L. darwinii Haeckel

Leucosolenia darwinii, Haeckel (1870) p. 243; Dendy and Row (1913) p. 725.
Ascaltis darwinii, Haeckel (1872) p. 57, Pl. 9, fig. 4; Pl. 10, fig. 3
Clathrina darwinii, Jenkin (1908) p. 436, text-figs. 81, 82.

37. L. minoricensis LACKSCHEWITZ

Leucosolenia minoricensis, LACKSCHEWITZ (1886) p. 301, Pl. 7, figs. 2, 3; DENDY and ROW (1913) p. 726.

38. L. serica TANITA

Leucosolenia serica, TANITA (1942) p. 25, Pl. 2, fig. 4, text-fig. 2.

Subdivision b) Triradiates smaller than quadriradiates

39. L. charybdaea (HAECKEL)

Ascaltis gegenbauri var. *charybdaea*, HAECKEL (1872) p. 62, Pl. 9, figs. 6–8; Pl. 10, fig. 5.

Leucosolenia charybdaea, DENDY and ROW (1913) p. 724.

40. L. gegenbauri HAECKEL

Leucosolenia gegenbauri, HAECKEL (1870) p. 243; DENDY and ROW (1913) p. 725.

Tarrus spongisus, HAECKEL (1870) p. 244.

Ascaltis gegenbauri, HAECKEL (1872) p. 62, Pl. 9, figs. 6–8; Pl. 10, fig. 5.

Subdivision c) Triradiates larger than quadriradiates

41. L. lamarckii HAECKEL

Leucosolenia lamarckii, HAECKEL (1870) p. 243; POLÉJAEFF (1883) p. 36; BREITFUSS (1897) p. 212; (1898) p. 14; p. 20; (1932) p. 242; LUNDBECK (1909) p. 457; DENDY and ROW (1913) p. 726.

Aulorrhiza intestinalis, HAECKEL (1870) p. 250.

Ascaltis lamarckii, HAECKEL (1872) p. 60, Pl. 9, fig. 5; Pl. 10, fig. 4; LENDENFELD (1885) p. 901; p. 1087.

Ascetta lamarckii, ARNESEN (1900) p. 11.

Subdivision d) Triradiates 2 kinds, large and small; quadriradiates equal to small triradiates.

42. L. decipiens (HAECKEL)

Ascaltis cerebrum var. *decipiens*, HAECKEL (1872) p. 54, Pl. 8, 10, fig. 2.

Leucosolenia decipiens, DENDY and ROW (1913) p. 725; HERNANDEZ (1918) p. 9; BREITFUSS (1935) p. 9.

43. L. depressa DENDY

Leucosolenia depressa, DENDY (1891) p. 65, Pl. 3, fig. 4; Pl. 8, fig. 8; Pl. 11, fig. 4; KIRK (1895) p. 209; DENDY and ROW (1913) p. 725.

44. L. gardineri DENDY

Leucosolenia gardineri, DENDY (1913) p. 2, Pl. 1, figs. 1, 2; Pl. 3, figs. 1–3; DENDY and ROW (1913) p. 725; HÔZAWA (1940) p. 35.

45. L. soyo HÔZAWA

Leucosolenia soyo, HÔZAWA (1933) p. 4, Pl. 1, fig. 2, text-fig. 1.

46. L. vitrea ROW and HÔZAWA

Leucosolenia vitrea, ROW and HÔZAWA (1931) p. 740, Pl. 19, fig. 2, text-fig. 2.

Division 9. Spicules sagittal

47. L. falklandica BREITFUSS

Leucosolenia falklandica, BREITFUSS (1898) p. 458, Pl. 27, figs. 3, 4; (1897) p. 211; DENDY and ROW (1913) p. 725; BURTON (1934) p. 8.

48. L. goethei HAECKEL

Leucosolenia goethei, HAECKEL (1870) p. 243; DENDY and ROW (1913) p. 725; BREITFUSS (1935) p. 10.
Ascaltis goethei, HAECKEL (1872) p. 64, Pl. 9, fig. 9; Pl. 10, fig. 6.
Ascetta goethei, LENDENFELD (1891) p. 220, Pl. 8, figs. 6, 17-20.

49. L. grantii HAECKEL

Leucosolenia grantii, HAECKEL (1870) p. 243; DENDY and ROW (1913) p. 725.
Ascaltis botryoides var. *solanderii*, HAECKEL (1872) p. 65, Pl. 9, fig. 10; Pl. 10, fig. 7.

50. L. multiformis BREITFUSS

Leucosolenia multiformis, BREITFUSS (1898) p. 15, Pl. 1, fig. 2; Pl. 4, fig. 26; p. 21; (1932) p. 242; DENDY and ROW (1913) p. 726.

51. L. solida BRØNDSTED

Leucosolenia solida, BRØNDSTED (1928) p. 17, text-fig. 17.

52. L. aboralis BRØNDSTED

Leucosolenia aboralis, BRØNDSTED (1928) p. 15, text-fig. 14.

Division 10. Spicules regular and sagittal

Subdivision a) No irregular spicules

53. L. grisea DENDY and FREDERICK

Leucosolenia grisea, DENDY and FREDERICK (1924) p. 480, Pl. 25, fig. 1; Pl. 26, fig. 1.

54. L. pelliculata DENDY

Leucosolenia pelliculata, DENDY (1891) p. 54, Pl. 3, fig. 2; Pl. 8, fig. 7; Pl. 10, figs. 1, 2; DENDY and ROW (1913) p. 726.

55. L. rosea KIRK

Leucosolenia rosea, KIRK (1895) p. 209, Pl. 3, fig. 1; DENDY and ROW (1913) p. 727.

Subdivision b) With irregular spicules

56. L. agassizii (HAECKEL)

Ascaltis lamarckii var. *agassizii*, HAECKEL (1872) p. 60, Pl. 9, fig. 5; Pl. 10, fig. 4.
Leucosolenia agassizii, DENDY and ROW (1913) p. 724; BREITFUSS (1932) p. 239

57. L. amitsbo HÔZAWA

Leucosolenia amitsbo, HÔZAWA (1929) p. 283, Pl. 1, figs. 3-5, text-fig. 2.

SECTION B. WITH OXEA

Group IV. With oxea and triradiates

Division 11. Triradiates regular

58. L. clarkii (VERRILL)

Ascortis clarkii, VERRILL (1873)

Leucosolenia clarkii, DENDY and ROW (1913) p. 721.

59. L. dubia DENDY

Leucosolenia dubia, DENDY (1891) p. 50, Pl. 1, fig. 3; Pl. 9, fig. 3; DENDY and ROW (1913) p. 722.

60. L. horrida (HAECKEL)

Ascortis horrida, HAECKEL (1872) p. 69, Pl. 11, fig. 1; Pl. 12, fig. 1.

Leucosolenia horrida, DENDY and ROW (1913) p. 722.

Division 12. Triradiates sagittal

61. L. angulata (LENDENFELD)

Ascandra angulata, LENDENFELD (1891) p. 226, Pl. 8, figs. 9-14; ARNESEN (1900) p. 13.

Leucosolenia angulata, DENDY and ROW (1913) p. 721; BREITFUSS (1927) p. 27.

62. L. corallorhiza (HAECKEL)

Sycorhiza corallorhiza, HAECKEL (1870) p. 249.

Ascortis corallorhiza, HAECKEL (1872) p. 73, Pl. 11, fig. 4; Pl. 12, fig. 4.

Ascandra corallorhiza, BREITFUSS (1898) p. 22; ARNESEN (1900) p. 14.

Leucosolenia corallorhiza, DENDY and ROW (1913) p. 721; BREITFUSS (1932) p. 241.

63. L. fabricii O. SCHMIDT

Leucosolenia fabricii, O. SCHMIDT (1870) p. 73; HAECKEL (1870) p. 243; DENDY and ROW (1913) p. 722; BREITFUSS (1927) p. 28; (1932) p. 241; (1936) p. 6.

Ascortis fabricii, HAECKEL (1872) p. 71, Pl. 11, fig. 3; Pl. 12, fig. 3.

Asandra fabricii. BREITFUSS (1897) p. 214; LUNDBECK (1909) p. 458.

64. L. lacunosa (JOHNSTON)

Grantia lacunosa, JOHNSTON (1842) p. 176, Pl. 20, figs. 2, 3.

Nardoa lacunosa, SCHMIDT (1862) p. 8; HAECKEL (1870) p. 247.

Leucosolenia lacunosa, BOWERBANK (1866) p. 32; (1872) p. 9, Pl. 4, figs. 1-8; GRAY (1867) p. 555; DENDY and ROW (1913) p. 722; BREITFUSS (1927) p. 28; (1932) p. 241; (1935) p. 11; BURTON (1930) p. 14; TOPSENT (1936) p. 14, figs. 6, 7.

Ascortis lacunosa, HAECKEL (1872) p. 70, Pl. 11, fig. 2; Pl. 12, fig. 2; HANITSCH (1890) p. 233.

Division 13. Triradiates irregular

65. L. fragilis (HAECKEL)

Leucosolenia thamnoides, HAECKEL (1870) p. 243.
Ascortis fragilis, HAECKEL (1872) p. 74, Pl. 11, figs. 5-9; Pl. 12, fig. 5.
Ascandra fragilis, BREITFUSS (1897) p. 214; ARNESEN (1900) p. 15.
Leucosolenia fragilis, DENDY and ROW (1913) p. 722; BREITFUSS (1927) p. 28; ARNDT (1928) p. 21, figs. 14, 15.

Group V. With oxea and quadriradiates

Division 14. Quadriradiates regular

66. L. irregularis JENKIN
Leucosolenia irregularis, JENKIN (1908) p. 440, text-figs. 80-90; DENEY and ROW (1913) p. 722.

Division 15. Quadriradiates sagittal

67. L. armata (HAECKEL)
Olynthus pocillum, HAECKEL (1870) p. 237.
Asculmis armata, HAECKEL (1872) p. 77, Pl. 13.
Ascandra armata, ARNESEN (1900) p. 13.
Leucosolenia armata, DENDY and ROW (1913) p. 721.

Division 16. Quadriradiates regular and sagittal

68. L. stolonifera DENDY
Leucosolenia stolonifera, DENDY (1891) p. 46, Pl. 1, fig. 2; Pl. 6, figs. 1-3; Pl. 9, fig. 2; DENDY and ROW (1913) p. 723; DENDY (1924) p. 275.

Group VI. With oxea, triradiates, and quadriradiates

Division 17. Radiates regular

Subdivision a) Tri- and Quadriradiates are not equal size

69. L. atlantica THACKER
Leucosolenia atlantica, THACKER (1908) p. 760, Pl. 40. fig. 2, text-fig. 156; DENDY and ROW (1913) p. 721.

70. L. falcata (HAECKEL)
Ascandra falcata, HAECKEL (1872) p. 83, Pl. 14, fig. 5.
Homandra falcata, LENDENFELD (1891) p. 229, Pl. 10, figs. 45-51; (1897) p. 215.
Leucosolenia falcata, DENDY and ROW (1913) p. 722; HERNANDEZ (1918) p. 10; BREITFUSS (1935) 9. 10; TOPSENT (1936) p. 37, figs. 19, 20.

71. L. izuensis TANITA
Leucosolenia izuensis, TANITA (1942) p. 21, Pl. 2, fig. 1, text-fig. 1.

72. L. ventricosa (CARTER)

Clathrina venticosa, CARTER (1885–1886) p. 512.

Leucosolenia ventricosa, DENDY (1891) p. 60, Pl. 1, figs. 8–10; Pl. 4, fig. 4; Pl. 10, fig. 4; (1918) p. 7; DENDY and ROW (1913) p. 724.

Ascandra ventricosa, BREITFUSS (1897) p. 215.

Subdivision b) Tri- and quadriradiates are of the same size.

1) Apical ray equal to facial rays in length

73. L. cordata (HAECKEL)

Ascandra cordata, HAECKEL (1872) p. 82, Pl. 14, fig. 1; Pl. 17, figs. 2, 6.

Leucosolenia cordata, DENDY and ROW (1913) p. 721.

74. L. densa (HAECKEL)

Tarrus densus, HAECKEL (1870) p. 244.

Nardopsis gracilis, HAECKEL (1870) p. 247.

Ascandra densa, HAECKEL (1872) p. 85, Pl. 14, fig. 2; Pl. 17, figs. 9, 12; LENDENFELD (1885) p. 902; p. 1088.

Leucosolenia densa, DENDY and ROW (1913) p. 721.

75. L. panis (HAECKEL)

Ascandra panis, HAECKEL (1872) p. 86, Pl. 14, fig. 3; Pl. 17, fig. 14.

Leucosolenia panis, THACKER (1908) p. 759, Pl. 40, fig. 1, text-fig. 155; DENDY and ROW (1913) p. 723.

76. L. reticulata (HAECKEL)

Tarrus reticulatus, HAECKEL (1870) p. 244.

Ascandra reticulum var. *reticulata*, HAECKEL (1872) p. 87, Pl. 14, fig. 4; Pl. 20.

Leucosolenia reticulata, DENDY and ROW (1913) p. 723; BREITFUSS (1932) p. 243.

77. L. reticulum (O. SCHMIDT)

Nardoa reticulum, O. SCHMIDT (1862)

Nardopsis reticulum, HAECKEL (1870) p. 247.

Tarrus reticulatus, HAECKEL (1870) p. 244.

Ascandra reticulum, HAECKEL (1872) p. 87, Pl. 14, fig. 4; Pl. 20; LENDENFELD (1891) p. 233, Pl. 8, figs. 7, 15; BREITFUSS (1897) p. 214; (1898) p. 23; p. 92.

Leucosolenia reticulum, DENDY and ROW (1913) p. 723; BREITFUSS (1932) p. 243; (1935) p. 14; TOPSENT (1936) p. 22, figs. 10, 11; HÔZAWA (1940) p. 32, text-fig. 2.

Clathrina reticulum, MINCHIN (1896)

2) Apical ray longer than facial rays

78. L. hermesi (BREITFUSS)

Ascandra hermesi, BREITFUSS (1896) p. 39, text-figs. 1, 2.

Leucosolenia hermesi, DENDY and ROW (1913) p. 722.

79. L. sagamiana HÔZAWA

Leucosolenia sagamiana, HÔZAWA (1929) p. 281, Pl. 1, figs. 1, 2; text-fig. 1.

80. L. tenuipilosa DENDY

Leucosolenia tenuipilosa, DENDY (1905) p. 227, Pl. 13, fig. 9; DENDY and ROW

(1913) p. 723.
Leucosolenia canariensis, THACKER (1908), fide ROW (1909).
Clathrina tenuipilosa, ROW (1909) p. 185.

3) Apical ray shorter than facial rays

81. L. cavata (CARTER)

Clathrina cavata, CARTER (1886) p. 502.
Leucosolenia cavata, DENDY (1891) p. 56, Pl. 2, fig. 7; Pl. 5, figs. 1. 2; Pl. 6, figs. 4, 5; Pl. 9, fig. 4; DENDY and ROW (1913) p. 724.
Ascandra cavata, BREITFUSS (1897) p. 213.

82. L. contorta BOWERBANK

Leucosolenia contorta, BOWERBANK (1866) p. 29; HAECKEL (1870) p. 243; DENDY and ROW (1913) p. 721; BREITFUSS (1927) p. 28; (1932) p. 241; TOPSENT (1936) p. 25, figs. 12, 13.
Ascandra contorta, HAECKEL (1872) p. 91, Pl. 14, fig. 6; HANITSCH (1890) p. 233; BREITFUSS (1897) p. 214; (1898) p. 15, Pl. 1, fig. 1; p. 22.
Clathrina contorta, MINCHIN (1896); JENKIN (1908) p. 437, text-fig. 83, 84.

83. L. laxa KIRK

Leucosolenia laxa, KIRK (1895) p. 208, Pl 4, fig. 1; DENDY and ROW (1913) p. 722; HÔZAWA (1928) p. 220, Pl. 1, figs. 4, 5; (1940) p. 35; TANITA (1941) p. 2, Pl. 1, fig. 1; p. 265; (1942) p. 23.

Division 18. Radiates sagittal; oxea 2 kinds

Subdivision a) Oxea with lance-head

84. L. arachnoides (HAECKEL)

Ascandra variabilis var. *arachnoides*, HAECKEL (1872) p. 106, Pl. 16, fig. 4.
Leucosolenia arachnoides, DENDY and ROW (1913) p. 721; BREITFUSS (1932) p. 240.

85. L. cervicornis (HAECKEL)

Ascandra variabilis var. *cervicornis*, HAECKEL (1872) p. 106, Pl. 16, fig. 4.
Leucosolenia cervicornis, DENDY and ROW (1931) p. 721; BREITFUSS (1932) p. 240.

86. L. confervicola (HAECKEL)

Ascandra variabilis var. *confervicola*, HAECKEL (1872) p. 106, Pl. 16, fig. 4.
Leucosolenia confervicola, DENDY and ROW (1913) p. 721; BREITFUSS (1932) p. 240.

87. L. hispidissima (HAECKEL)

Ascandra variabilis var. *hispidissima*, HAECKEL (1872) p. 106, Pl. 16, fig. 4.
Leucosolenia hipidissima, DENDY and ROW (1913) p. 722; BREITFUSS (1932) p. 241.

88. L. pinus (HAECKEL)

Ascandra pinus, HAECKEL (1872) p. 105, Pl. 16, fig. 3.
Leucosolenia pinus, DENDY and ROW (1913) p. 723.

89. L. variabilis HAECKEL

Leucosolenia variabilis, HAECKEL (1870) p. 243; MINCHIN (1905) p. 373, text-figs.

94–96; Dendy and Row (1913) p. 723; Breitfuss (1927) p. 28; (1932) p. 243.
Ascandra variabilis, Haeckel (1782) p. 106, Pl. 16, fig. 4; Breitfuss (1897) p. 215; (1898) p. 16; p. 23; Arnesen (1900) p. 15; Lundbeck (1909) p. 459.

Subdivision b) Oxea sharply pointed at both ends

90. L. incerta Urban

Leucosolenia incerta, Urban (1908) p. 247; p. 5, Pl. 1, fig. 1; Dendy and Row (1913) p. 722.

91. L. mollis Tanita

Leucosolenia mollis, Tanita (1941) p. 265, Pl. 17, fig. 2, text-fig. 1.

92. L. pilosella Brøndsted

Leucosolenia pilosella, Brøndsted (1928) p. 17, text-fig. 18.

Division 19. Radiates sagittal; oxea 1 kind

Subdivision a) Basal ray longest, apical ray shortest

93. L. amoeboides Haeckel

Leucosolenia amoeboides, Haeckel (1870) p. 237; Dendy and Row (1913) p. 720; Breitfuss (1932) p. 239.
Ascandra complicata var. *amoeboides*, Haeckel (1872) p. 93, Pl. 15, fig. 1.

94. L. australis Brøndsted

Leucosolenia australis, Brøndsted (1928) p. 15, text-fig. 15, 16.

95. L. complicata (Montagu)

Spongia complicata, Montagu (1812) p. 97, Pl. 9, figs. 2. 3.
Grantia botryoides, Lieberkühn (1859) p. 373.
Olynthus hispidus, Haeckel (1870) p. 237.
Leucosolenia complicata, Haeckel (1870) p. 243; Minchin (1905) p. 360, text-figs. 91–93; Jenkin (1908) p. 6; Dendy and Row (1913) p. 721; Breitfuss (1927) p. 27; (1932) p. 240; (1936) p. 5; Arndt (1928) p. 22, figs. 16, 17; Topsent (1936) p. 27, figs. 14–16; Hôzawa (1940) p. 132, Pl. 6, fig. 1, text-fig. 1.
Ascandra complicata, Haeckel (1872) p. 93, Pl. 15, fig. 1; Breitfuss (1897) p. 213; (1898) p. 22; Arnesen (1900) p. 13; Lundbeck (1909) p. 458.

96. L. discoveryi Jenkin

Leucosolenia discoveryi, Jenkin (1908) p. 6, Pl. 28, figs. 12, 13; Dendy and Row (1913) p 722; Burton (1932) p. 258.

97. L. minchin Jenkin

Leucosolenia minchin, Jenkin (1908) p. 8, Pl. 28, figs. 14, 15; Dendy and Row (1913) p. 723; Brøndsted (1928) p. 14, figs. 12, 13.

Subdivision b) Basal and paired rays equal, longer than apical

98. L. eleanor Urban

Leucosolenia eleanor, Urban (1905) p. 36, Pl. 6, figs. 1–62; Pl. 7, figs. 63–68; Dendy and Row (1913) p. 722; Laubenfels (1932) p. 8, fig. 3.

99. L. lucasi DENDY

Leucosolenia lucasi, DENDY (1891) p. 45, Pl. 1, fig. 1; Pl. 4, fig. 1; Pl. 9, fig. 1; KIRK (1893) p. 178, Pl. 22, fig. 2; TOPSENT (1907) p. 539; BRØNDSTED (1926) p. 298, fig. 1; ROW and HÔZAWA (1931) p. 729.

Leucosolenia bella, DENDY and ROW (1913) p. 721.

Subdivision c) Paired rays longest, apical shortest

100. L. albatrossi HÔZAWA

Leucosolenia albatrossi, HÔZAWA (1918) p. 526, Pl. 84, fig. 1, text-fig. 1.

101. L. botryoides (ELLIS and SOLANDER)

Spongia botryoides, ELLIS and SOLANDER (1786) p. 190, Pl. 58, figs. 1–4.

Grantia botryoides, JOHNSTON (1842) p. 178, Pl. 21, fig. 1.

Leucosolenia botryoides, BOWERBANK (1866) p. 28, Pl. 26, figs. 347, 348; GRAY (1867) p. 555; HAECKEL (1870) p. 243; BREITFUSS (1897) p. 210; (1927) p. 27; (1932) p. 240; MINCHIN (1905) p. 386, figs. 97, 98; DENDY and ROW (1913) p. 721; DENDY (1918) p. 5, Pl. 1, figs. 1, 6; ARNDT (1928) p. 20, figs. 10–12; BURTON (1929) p. 401; TOPSENT (1936) p. 33, figs. 17, 18.

Leucosolenia grantii, HAECKEL (1870) p. 243.

Ascaltis botryoides, HANITSCH (1890) p. 233.

102. L. lieberkühnii (O. SCHMIDT)

Grantia lieberkühnii, O. SCHMIDT (1862) p. 17.

Leucosolenia robusta, HAECKEL (1870) p. 243.

Leucosolenia lieberkühnii, HAECKEL (1870) p. 243; DENDY and ROW (1913) p. 723; BREITFUSS (1935) p. 11.

Ascandra lieberkühnii, HAECKEL (1872) p. 96, Pl. 15, fig. 2; LENDENFELD (1891) p. 224, Pl. 8, fig. 8.

103. L. tenera TANITA

Leucosolenia tenera, TANITA (1940) p. 166, Pl. 8, fig. 2, text-fig. 1; (1941) p. 2, Pl. 1, fig. 2; p. 267; (1942) p. 27.

104. L. tenuis (SCHUFFNER)

Ascandra tenuis, SCHUFFNER (1877) p. 406. Pl. 25, fig. 8.

Leucosolenia tenuis, DENDY and ROW (1913) p. 723.

Subdivision d) Basal ray and the apical equal, but shorter than paired rays

105. L. botrys (HAECKEL)

Ascandra botrys, HAECKEL (1872) p, 101, Pl. 16, fig. 1; BREITFUSS (1897) p. 213.

Leucosolenia botrys, DENDY and ROW (1913) p. 721; BREITFUSS (1927) p. 27.

106. L. sertularia (HAECKEL)

Ascandra sertularia, HAECKEL (1872) p. 100, Pl. 15, fig. 4.

Leucosolenia sertularia, DENDY and ROW (1913) p. 723.

Subdivision e) Paired rays longest, basal shortest

107. L. echinoides HAECKEL

Leucosolenia echinoides, HAECKEL (1870) p. 244; DENDY and ROW (1913) p. 722.
Olynthus cyathus, HAECKEL (1870) p. 237.
Ascandra echinoides, HAECKEL (1872) p. 98, Pl. 15, fig. 3.

Subdivision f) Basal ray shortest, paired and apical rays equal

108. L. nitida (HAECKEL)
Olynthium nitidum, HAECKEL (1870) p. 237.
Olynthium splendidum. HAECKEL (1870) p. 237.
Ascandra nitida, HAECKEL (1872) p. 103, Pl. 16, fig. 2.
Leucosolenia nitida, DENDY and ROW (1913) p. 723.

Subdivision g) Length ratio of rays not constant

109. L. hispida BRØNDSTED
Leucosolenia hispida, BRØNDSTED (1928) p. 12, figs. 9-11.

Division 20. Radiates regular and sagittal

110. L. echinata KIRK
Leucosolenia echinata, KIRK (1893) p. 177, Pl. 22, fig. 1; DENDY and ROW (1913) p. 722; BRØNDSTED (1926) p. 299.

THE DISTRIBUTION OF *LEUCOSOLENIA*

The number of species of the genus *Leucosolenia* is estimated to be over one hundred as above mentioned and, thus, to deal with their geographical distribution seems to be rather interesting. In the seas of Europe and Australia the calcareous sponges have been subjected to an extensive collection and the researches upon them have been executed pretty throughly, but still a number of new forms will be found presently when more collections are made. Thus it may be probable that some species which were at first to be entirely local, will be found by later study to occur in wider distribution. The sponges of the coasts of Africa and South America are very little known now, thus the geographical distribution of sponges may become more clear, when more collections have been made and the species have been more elucidated.

For the sake of convenience, I have divided the localities where they were found into six regions, adding one more region to receive the cosmopolitic species.

		No. sp.
I.	Cosmopolitan	9.
II.	Pacific Ocean (including the coasts of Australia and of New Zealand)	44.

III.	Atlantic Ocean	32.
IV.	Mediterreanian Sea	17.
V.	Indian Ocean	7.
VI.	Arctic Region	4.
VII.	Antarctic Region	8.

Their distribution is shown in the following table, the species being alphabetically arranged.

I. Cosmopolitan

L. blanca (Michlucho-Maclay)
L. canariensis (Michlucho-Maclay)
L. coriacea (Montagu)
L. dictyoides Haeckel
L. loculosa (Haeckel)
L. macleayi (Lendenfeld)
L. poterium (Haeckel)
L. primordialis (Haeckel)
L. protogenes (Haeckel)

II. Pacific Ocean

1) Coasts of Japan

L. amitsbo Hôzawa
*L. gardineri** Dendy
L. izuensis Tanita
L. japonica (Haeckel)
L. kagoshimensis Hôzawa
*L. laxa** Kirk
L. mollis Tanita
L. mutsu Hôzawa
L. sagamiana Hôzawa
L. serica Tanita
L. soyo Hôzawa
L. tenera Tanita
L. ventosa Hôzawa

2) Coasts of Australia and New Zealand

L. cavata (Carter)
*L. cerebrum** (Haeckel)
L. challengeri Poléjaeff
L. clathrata (Carter)
*L. clathrus** (O. Schmidt)
L. densa (Haeckel)
L. depressa Dendy
L. dubia Dendy
L. echinata Kirk
*L. gracilis** (Haeckel)
L. grisea Dendy and Frederick
*L. lamarckii** (Haeckel)
*L. laxa** Kirk
L. lucasi Dendy
L. osculum (Carter)
L. pedunculata (Lendenfeld)
L. pelliculata Dendy
L. proxima Dendy
L. psammophila Row and Hôzawa
L. pulcherrima Dendy
L. rosea Kirk
L. stipitata Dendy
L. stolonifera Dendy
L. ventricosa (Carter)
L. vitrea Row and Hôzawa
L. wilsoni Dendy

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* indicates the sponges found also in other region.

3) Coasts of North America

L. albatrossi Hôzawa
L. convallaria (Haeckel)
*L. gracilis** (Haeckel)
L. vesicula (Haeckel)
L. clarkii (Verrill)
L. eleanor Urban
*L. phillipina** (Haeckel)

III. Atlantic Ocean

1) Coasts of Europe

*L. agassizii** (Haeckel)
*L. arachnoides** (Haeckel)
L. botryoides (Ellis and Solander)
*L. cervicornis** (Haeckel)
*L. confervicola** (Haeckel)
L. corallorhiza (Haeckel)
L. grantii Haeckel
*L. hispidissima** (Haeckel)
*L. lamarckii** Haeckel
*L. reticulum** (O. Schmidt)
L. tenuis (Schuffner)
L. amoeboides Haeckel
L. armata (Haeckel)
L. botrys (Haeckel)
*L. complicata** (Montagu)
*L. contorta** Bowerbank
*L. fragilis** (Haeckel)
L. himantia (Johnston)
*L. lacunosa** (Johnston)
L. pinus (Haeckel)
*L. sagittaria** (Haeckel)
*L. variabilis** Haeckel

2) Coasts of Africa

*L. arachnoides** (Haeckel)
*L. cervicornis** (Haeckel)
L. cordata (Haeckel)
L. nitida (Haeckel)
*L. variabilis** (Haeckel)
L. atlantica Thacker
*L. confervicola** (Haeckel)
*L. hispidissima** (Haeckel)
*L. panis** (Haeckel)

3) Coasts of North America

*L. agassizii** (Haeckel)
L. fabricii O. Schmidt
L. horrida (Haeakel)
*L. panis** (Haeckel)
L. cancellata Verrill
*L. fragilis** (Haeckel)
*L. lamarckii** (Haeckel)
L. sceptrum (Haeckel)

4) Coasts of South America

L. falklandica Breitfuss
*L. phillipina** (Haeckel)

IV. Mediterreanian Sea

L. angulata (Lendenfeld)
L. charybdaea (Haeckel)
*L. complicata** (Montagu)
L. echinoides Haeckel
L. gegenbauri Haeckel
*L. cerebrum** (Haeckel)
*L. clathrus** (O. Schmidt)
L. decipiens (Haeckel)
L. falcata (Haeckel)
L. goethei Haeckel

L. hermesi (Breitftss)
L. lieberkühnii (O. Schmidt)
L. reticulata (Haeckel)
L. spinosa (Lendenfeld)
*L. lacunosa** (Johnston)
L. minoricensis Lackschewitz
*L. reticulum** (O. Schmidt)

V. Indian Ocean

L. caroli (Haeckel)
L. flexilis (Haeckel)
L. irregularis Jenkin
L. tenuipilosa Dendy
L. darwinii Haeckel
*L. gardineri** Dendy
L. sertularia (Haeckel)

VI. Arctic Region

*L. contorta** Bowerbank
L. multiformis Breitfuss
*L. lacunosa** (Johnston)
*L. sagittaria** (Haeckel)

VII. Antarctic Region

L. aboralis Brϕndsted
L. discoveryi Jenkin
L. incerta Urban
L. pilosella Brϕndsted
L. australis Brϕndsted
L. hispida Brϕndsted
L. minchin Jenkin
L. solida Brϕndsted

LITERATURE CITED

Arndt, W, (1928). Porifera. Tierwelt Deutschland. pp. 1–94.

Arnesen, E. (1900). Spongier fra den norske kyst. I. Calcarea. Systematisk katalog med bemerkninger og bestemmelsestabel. Bergens Mus. Aarbog, No. 5.

Bowerbank, J. S. (1) (1864–1882). A Monograph of the British Spongiadae. Ray Soc., London, 4 Vols.

—— (2) (1872). Contributions to a General History of the Spongiadae. Proc. Zool. Soc., London, pp. 115–129, 196–202, 626–634, Pls. 5, 6, 10, 11, 46–49.

Breitfuss, L. (1) (1896). *Ascandra Hermesi*, ein neuer homocoeler Kalkschwamm aus der Adria. Zeit. wiss. Zool., Bd. 63, Heft. 1, pp. 39–42.

—— (2) (1897). Catalog der Calcarea der zoologischen Sammlung des königlichen Museums für Naturkunde zu Berlin. Arch. Naturgesch. Jahrgang 63, Bd. 1, pp. 205–226.

—— (3) (1898). Kalkschwammfauna des weissen Meeres und der Eismeerküsten des europäischer Russlands mit Berücksichtigung und Aufstellung der Kalkschwammfauna der arktischen Region. Mémores de l'Acad. Imp. Scences, St. Pétersbourg, ser. 8, Vol. 6, No. 2.

—— (4) (1898). Die arctische Kalkschwammfauna. Inaugural-Dissertation zur Erlangung der Doctorwürde von der Philos. Fak. Univ. Zürich, pp. 1-40.

—— (5) (1898). Kalkschwammfauna der Westküste Portugals. Zool. Jahrb. Syst. Abth., Bd. 11, pp. 89–102.

—— (6) (1898). Die Kalkschwämme der Sammlung Plate (Fauna Chilensis, Bd. 1) Zool.

Jahrb. Suppl., Bd. 4, pp. 455-470.

—— (7) (1927). Die Kalkschwammfauna der Nord- und Ostsee. Zool. Anz., Bd. 70, pp. 26-36.

—— (8) (1932). Die Kalkschwammfauna des arktischen Gebietes. Fauna arctica, pp. 237-252.

—— (9) (1935). Le Spugne calcaree dell'Adriatico con riflesso a tutto il Mediterraneo. Comitato Talassografico Italiano, Mem. 223, pp. 1-43.

—— (10) (1936). Kalkschwämme vom Skagerrak und Kattegat unter Berücksichtigung ihrer Weltverbreitung. Göteborgs Kungl. Vetenskops och Vitterhets Samhälles Handlingar Femte Följden. Ser. B, Bd. 4, No. 15.

BRØNDSTED. H. V. (1) (1926). Sponges from New Zealand. Part II. Paper from Dr. TH. MORTENSEN's Pacific Expedition 1914-16 XXXV. Vidensk. Medd fra Dansk Naturh. Foren, Bd. 81, pp. 295-331.

—— (2) (1928). Die Kalkschwämme der deutschen Südpolar-Expedition 1901-1903. Deutsche Südpolar-Expedition XX. Zoologie, pp. 1-47.

BURTON, M. (1) (1926). Report on the Sponges. Trans. Zool. Soc., Part 1, 1926, pp. 71-83.

—— (2) (1929). British Antarctic Expedition, 1910. Porifera. Part II. Antarctic Sponges. Nat. Hist. Rep. Zool., Vol. 6, No. 4, pp. 393-458, Pls. 1-5.

—— (3) (1930). The Porifera of the Siboga Expedition, III. Calcarea. Siboga Expeditie.

—— (4) (1930). Norwegian Sponges from the Norman Collection. Proc. Zool. Soc., London, 1930, pp. 32-546, Pls. 1, 2.

—— (5) (1932). Sponge. Discovery Report Vol. 6, pp. 237-392, Pls. 48-57.

—— (6) (1933). Report on a small Collection of Sponges from Still Bay, S. Africa. Ann. Mag. Nat. Hist. Ser. 10, Vol. 11, p. 235.

—— (7) (1934). Sponges. Further Zoological Results of the Swedish Antarctic Expedition 1901-1903. Vol. III, No. 2, Pls. 8.

BURTON, M. and RAO, H. S. (1932). Report on the Shallow-water Marine Sponges in the Collection of the Indian Museum. Rec. Indian Mus., Vol. 34, Part III. pp. 299-356, Pl. 18.

CARTER, H. J. (1) (1871). On two undescribed Sponges and two Esperiadae from the West Indies; also on the nomenclature of the Calcisponge *Clathrina*, GRAY. Ann. Mag. Nat. Hist. Ser. 4, Vol. 7, pp. 268-283.

—— (2) (1877). Arctic and Antarctic Sponges. Ann. Mag. Nat. Hist. Ser. 4, Vol. 20, pp. 38-42.

—— (3) (1883). Further Observations on the so-called 'Farringdon Sponges' (*Calcispongiae*, ZITTEL), followed by a description of an existing species of a like kind (*Leucetta clathrata*, n. sp.). Ann. Mag. Nat. Hist. Ser. 5, Vol. 11, pp. 20-37.

—— (4) (1885-1886) Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia. Ann. Mag. Nat. Hist. Ser. 5, Vol. 17, pp. 431-441; 502-516; Vol. 18, pp. 34-55; 126-149.

DENDY, A. (1) (1891). A Monograph of the Victorian Sponges. Part I. The Organization and Classification of the Calcarea Homocoela, with descriptions of the Victorian Species. Trans. Roy. Soc., Victoria, Vol. 3, No. 1, pp. 1-82, Pls. 1-9.

—— (2) (1893). On a new species of *Leucosolenia* from Port Phillip Heads. Proc. Roy. Soc. Vict. Vol. 5, pp. 178-180.

—— (3) (1905). Report on the Sponges collected by Prof. HERDMAN at Ceylon in 1902. Rep. Pearl Oyster Fish. Gulf Manaar, Vol. 3, pp. 59-246. Pls. 1-16.

—— (4) (1913). Report on the Calcareous Sponges collected by the Sealark Expedition in the Indian Ocean. Trans. Linn. Soc. London, Zool., Vol. 16, pp. 1-29, Pls. 1-4.

—— (5) (1918). Calcareous Sponges. Australian Antarctic Expedition 1911-14. Scientific Reports, Ser. C. Zoology and Botany Vol. 6, part 1.

—— (6) (1924). Porifera. Part II. Non Antarctic Sponges. British Antarctic Expedition, 1910. Nat. Hist. Rep. Zool., Vol. 6, No. 3, pp. 269-392, Pls. 1-15.

DENDY, A. and FREDERICK, L. M. (1924). On a Collection of Sponges from the Abrolhos Islands, Western Australia. Journ. Linn. Soc. London, Zool., Vol. 35, pp. 477-518, Pls. 25, 26.

DENDY, A. and ROW, R. W. H. (1913). The Classification and Phylogeny of the Calcareous Sponges, with a Reference List of all the described Species, systematically arranged. Proc. Zool. Soc. London, 1913, pp. 704-813.

ELLIS, J. and SOLANDER, D. (1786). Natural History of many curious and uncommon Zoophytes collected from various parts of the Globe. London.

FRISTED, K. (1887). Sponges from Atlantic and Arctic Oceans, and the Behring Sea (Vega Expedition). Vega Exped. Ventensk. Lakttag, Vol. 4, pp. 401-471.

GRAY, J. E, (1867). Notes on the Arrangement of Sponges with descriptions of some New Genera. Proc. Zool. Soc. London, pp. 492-558, Pls. 27, 28.

HAECKEL, E. (1) (1870). Prodromus eines Systems der Kalkschwämme. Jena. Zeits., Vol. 5, pp. 236-254.

—— (2) (1872). Die Kalkschwämme, eine Monographie. Berlin.

HANITSCH, R. (1) (1890). Third Report on the Porifera of the L. M. B. C. District. Proc. Liverpool Biol. Soc., Vol. 4, pp. 192-238, Pls. 10-15.

—— (2) (1895). Notes on a Collection of Sponges from the West Coast of Portugal. Trans. Liverpool Biol. Soc., Vol. 9, pp. 205-219, Pls. 12, 13.

HERNANDEZ, F. F. (1918). Esponjas del Litoral de Asturias. Trabajos del Museo de Ciencias Nat., ser. Zool. Num. 36, pp. 1-39.

HÔZAWA, S. (1) (1918). Report on the Calcareous Sponges collected by the U. S. Fisheries Steamer "Albatross" in the Northwestern Pacific during 1906. Proc. U. S. Nat. Mus., Vol. 54, pp. 525-556, Pls. 84, 85.

—— (2) (1928). Report of the Biological Survey of Mutsu Bay. 6. Calcarea of Mutsu Bay. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 3, pp. 219-221, Pl. 1.

—— (3) (1929). Studies on the Calcareous Sponges of Japan. Journ. Fac. Sci. Imp. Uuiv. Tokyo, Sec. IV, Zool., Vol. 1, part 5, pp. 277-389, Pls. 1-12.

—— (4) (1933). Report on the Calcareous Sponges obtained by the Survey of the Continental Shelf bordering on Japan. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 8, pp. 1-20, Pl. 1.

—— (5) (1940). On Some Calcareous Sponges from Japan. Sci. Rep. Tokoku Imp. Univ. Biol., Vol. 15, No. 1, pp. 29-58, Pls. 4, 5.

—— (6) (1940). Report on the Calcareous Sponges obtained by the Zoological Institute and Museum of Hamburg. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 15, No. 2, pp. 131-163, Pls. 6, 7.

JAMES-CLARK, H. (1869). On the Spongiae Ciliatae as Infusoria Flagellata; or Observations on the Structure, Animality, and Relationships of *Leucosolenia botryoides* BDK. Mem. Boston Soc. Nat. Hist., Vol. 1, pp. 305-340.

JENKIN, C. F. (1) (1908). The Marine Fauna of Zanzibar and British East Africa, from Collections made by CYRIL CROSSLAND, M. A., in the Years 1901 & 1902. The Calcareous Sponges. Proc. Zool. Soc. London, pp. 434-456.

—— (2) (1908). The Calcarea of the National Antarctic Expedition. Nat. Hist. Rep., Vol.

4, pp. 182–311, Pls. 27–38.

JOHNSTON, G. (1842). A History of British Sponges and Lithophytes. Edinburgh.

KIRK, H. B. (1) (1893). Contribution to a knowledg of the New Zealand Sponges. Trans. New Zealand Instit., Vol. 26, pp. 175–179, Pl. 22.

—— (2) (1895). New Zealand Sponges. Third Paper. Trans. New Zealand Instit., Vol. 28, pp. 205–210, Pls. 3, 4.

LACKSCHEWITZ, P. (1886). Ueber die Kalkschwämme Menorcas. Zool. Jahrb., Vol. 1. pp. 297–310.

LAMBE, L. M. (1896). Sponges from the Atlantic Coast of Canada. Proc. Trans. Roy. Soc. Canada, ser. 2, Vol. 11, pp. 181–211, Pls. 1–3,

—— (2) (1900). Descriptions of a new Species of Calcareous Sponges from Vancouver Island, B.C. Ottawa Naturalist, Vol. 13, No. 11, pp. 261–263.

—— (3) (1900). Sponges from the Coasts of North-eastern Canada and Greenland. Trans. Roy. Soc. Canada, ser. 2, Vol. 6, pp. 19–48, Pls. 1–6.

—— (4) (1900). Catalogue of the Recent Marine Sponges of Canada and Alaska. Ottawa Nat., Vol. 14, No. 9, pp. 153–172.

LAUBENFELS, M. W. (1932). The Marine and Fresh-water Sponges of California. Proc. U. S. Nat. Mus., Vol. 81, Art 4, pp. 1–140.

LENDENFELD, R. (1) (1885). The Homocoela of Australia and the new Family Homodermidae. Proc. Linn. Soc. New South Wales, Vol. 9, pp. 896–907.

—— (2) (1885). A Monograph of the Australian Sponges. Part III. The Calcispongiae. Proc. Linn. Soc. New South Wales, Vol. 9, pp. 1083–1150, Pls. 59–67.

—— (3) (1891). Die Spongien der Adria. I. Die Kalkschwämme. Zeits. wiss. Zool., Bd. 53, Heft 2, pp. 185–321, Pls. 8–15; Heft 3, pp. 361–463.

LIEBERKÜHN, N. (1859). Neue Beiträge zur Anatomie der Spongien. Müller's Archiv., 1859, pp. 353–382; 515–530.

LUNDBECK, W. (1909). The Porifera of East-Greenland. Meddel. Grönland Copenhagen. pp. 1–44, Pl. 1.

MICHLUCHO-MACLAY, N. (1868). Beiträge zur Kenntniss der Spongien. I. Ueber *Guancha blanca*, einen neuen Kalkschwamm. Jena. Zeits., Vol. 4, pp. 221–240.

MINCHIN, E. A. (1) (1896). Suggestions for a Natural Classification of the Asconoidae. Ann. Mag. Nat. Hist. ser. 6, Vol. 18, pp. 349–362.

—— (2) (1905). The Characters and Synonymy of the British Species of Sponges of the Genus *Leucosolenia*. Proc. Zool. Soc. London, Vol. 2, pp. 349–396.

MONTAGU, G. (1812). An Essay on Sponges, with Descriptions of all the Species that have been discovered on the Coast of Great Britain. Mem. Wern. Soc. Edinburgh, Vol. 2, pp. 67–122.

POLÉJAEFF, N. (1883). The Calcarea. Report on the Scientific Results of the Voyage of H. M. S. "Challenger". Zoology Vol. 8.

RIDLEY, S. O. (1881). Spongida collected during the Expedition of H. M. S. Alert in the Straits of Magellan and on the Coast of Patagonia. Proc. Zool. Soc. London, 1881, pp. 107–137, Pls. 10, 11.

ROW, R. W. H. (1909). Reports on the Marine Biology of the Sudanese Red Sea. XIX. Report on the Sponges collected by Mr. CYRIL CROSSLAND in 1904–1905. Part I. Calcarea. Journ. Linn. Soc. London, Zool., Vol. 31, pp. 182–214, Pls. 19, 20.

ROW, R. W. H. and HÔZAWA, S. (1931). Report on the Calcarea obtained by the Hamburg South-West Australian Expedition of 1905. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 6, No. 4, pp. 727–809, Pls. 19–21.

SCHMIDT, O. (1862). Die Spongien des Adriatischen Meeres. Leipzig, 1862.

SCHUFFNER, O. (1877). Beschreibung einiger neuer Kalkschwämme. Jena. Zeits., Vol. 11, pp. 403–433, Pls. 24–26.

TANITA, S. (1) (1940). Calcareous Sponges of Matsushima Bay. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 15, No. 2, pp. 165–177, Pl. 8.

—— (2) (1941). Report of the Biological Survey of Mutsu Bay. 35. Studies on the Calcarea of Mutsu Bay. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 16, No. 1, pp. 1–8, Pl. 1.

—— (3) (1941). Calcareous Sponges obtained from Onagawa Bay and its Vicinity. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 16, No. 3, pp. 263–282, Pl. 17.

—— (4) (1942). Calcareous Sponges obtained from the Kantô District, Japan. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 17, No. 1, pp. 17–69, Pls. 2–4.

THACKER, A. G. (1908). On Collections of the Cape Verde Islands Fauna made by CYRIL CROSSLAND, M. A., from July to September 1904. The Calcareous Sponges. Proc. Zool. Soc. London, pp. 757–782, Pl. 40.

TOPSENT, E. (1) (1907). Sponges calcaires recueilles par ln Francais dans l'Antarctique (Expédition du Dr. CHARCOT). Bull. Mus. Hist. Nat., Paris, 1907, pp. 539–544.

—— (2) (1936). Etude sur des *Leucosolenia.* Bull. l'Institut Océano., No. 711, pp. 1–47.

URBAN, F. (1) (1905). Kalifornische Kalkschwämme. Archiv. f. Naturgesch. Jahrg. 72, Bd. 1, pp. 33–76.

—— (2) (1908). Die Kalkschwämme der deutschen Tiefsee-Expedition. Zool. Anz., Bd. 33, pp. 247–252.

—— (3) (1909). Die Calcarea. Wiss. Ergeb. deut. Tiefsee-Exped. (Valdivia), Bd. 19, Jena.

VERRILL, A. E. (1874). Exploration of Casco Bay by the U. S. Fish Commission in 1813. Proc. Amer. Assoc. Advance Sci., Part 2, pp. 340–395.

VOSMAER, G. C. J. (1887). Porifera. Die Klassen und Ordnungen des Thierreichs, wissenschaftlich dargestellt in Wort und Bild, von Dr. H. G. BRONN. Bd. 2, Leipzig und Heidelberg, 1887.

STUDY OF THE FILAMENTOUS FUNGI OF THE SOIL OF SOLFATARA[1]

BY

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(With Plate V and 4 Text-figures)

(Received December 13, 1941)

INTRODUCTION

Mt. Hakkôda, the site of the Botanical Laboratory of Tôhoku Imperial University, is well known in this country as a balneological region, richly distributed with hot springs and solfataras, some of which are located in or near the compound of the said laboratory.

Now, it may not need special mention that the solfatara area is not well fitted for the luxurious development of vegetation. Extremely acidic reaction of the soil, deficiency of nitrogenous and other mineral nutrients, excess of dissociated aluminum, too high soil temperature and, especially, the evolution of toxic gases, all seem to preclude the development of ordinary plants, only some resistant forms being allowed to invade the district.

On Mt. Hakkôda, *Cladonia polydactyla*, *Miscanthus sinensis*, *Hydrangea paniculata*, *Polygonum sachalinense*, etc. may be enumerated as examples of the most common of solfatara plants, that is, the most resistant forms to these unfavorable conditions. Towards the center of the solfatara, however, even these resistant forms are not admitted, and it is not of rare occurrence that an area of land remains entirely uncovered. These peculiarities of solfatara have naturally long since attracted the interest of botanists, and so far as the macrophytes are concerned, many valuable investigations, both synecological and autecological, have hitherto been made.[2] As for the microbial population of solfatara, however, almost nothing has hitherto been reported, at least in our country. Accordingly, the writer, thinking it worth while to pursue the latter problem, carried on some microbiological examinations during his stay in the Laboratory, the results of which are to be reported briefly below.

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[1] Contributions from the Mt. Hakkôda Botanical Laboratory, No. 28.

[2] H. MOLISH: Ueber die Solfataraflora Japans nebst Bemerkungen über die Strandflora. Pflanzenbiologie in Japan auf Grund eigener Beobachtungen. 1926, Jena, p. 248. M. TAKAMATSU: Studien über die Mykorrhyza-Pflanzen in Solfatara-Gebiete auf dem Berg Hakkôda. Sci. Rep.. Tôhoku Imp. Univ., 4 Ser., Vol. 5, p. 607, 1930. Y. YOSHII: Aluminium Requirements of Solfatara-plants. Bot. Mag. Tokyo, Vol. 51, p. 262, 1937.

Location of the Solfatara Studied

All of the localities studied were in or near the compound of Mt. Hakkôda Botanical Laboratory. The bare land at the center of the solfatara and the Cladonietum directly neighbouring the bare land were studied. Pedological studies in detail were not accomplished, yet it may be worth mention that the pH of these solfatara soils are extremely small, that is, the reactions are highly acidic, the numerical values of which are shown in Table 1.

Table 1. The Fields of Study

Fields of Study	pH of the Soil*
A_1....Bare land, ca. 30～50 m East of Digokunuma, ca. 900 m above sea level.	2.0～2.2
A_2....Bare land, ca. 150 m N-W of Digokunuma, ca. 900 m above sea level.	1.4～1.6
A_3....Bare land on the shore of Yatiyunuma, ca. 900 m above sea level.	2.6～2.8
B ....Cladonietum, directly neighbouring the bare land A_1.	2.8～3.1

* Results obtained by the colorimetric test with water extracts of the soils.

Of the fields above tabulated, A_1, as shown in text-figure 1, is wholly devoid of higher plants. It is located in an abandoned region unfrequented by human visitors, so that this point was selected as representative of the present study, and both the plating and direct streak method were applied to study the number and the kind of fungi in the soil. As for the other fields of study, only the latter method was employed.

Fungal Population in the Soil of Solfatara

(I) *Result of the plating method.* As is described just above, plot A_1 was subjected to the study. The soil about 3～6 cm deep was sampled with a trowel and a spatula, packed in a Petri dish, and brought back to the laboratory, where it was counterpoised, diluted and plated. All the subjects coming in contact with the soil samples were previously sterilized.

Text-fig. 1. Locality A_1. The bare land near Digokunuma. (indicated with an arrow-head)

The procedures in the laboratory were carried out in an inoculation chest. WAKSMAN's peptone-glucose acid agar (pH 3.8~4.0)[1] was used as the plating medium. Two classes of dilution, viz., 1/100 and 1/1000 were preliminarily tested, of which the latter was proved to give satisfactory results, while the former was found to develop too many crowded colonies. Five plates were prepared in parallel, and they were incubated for 7 days at a temperature of 27~28°C, at the end of which period the fungal colonies were counted. The period of incubation was a little longer than in ordinary practice, for the fungal colonies in our study were unusually slow in development. The results of the study proved that the soil in question contains about 4700 fungi per 1 g fresh weight or about 8000 per 1 g dry weight of the soil (water content of the sample being 41.6%).

As a control test to the above plating, the identical sample of soil was heated in an oven for one hour at 160°C, then cooled, counterpoised, diluted and plated with entirely the same procedure. At the expiration of the same period of incubation, these plates of control were found to produce not a single colony of microbe, so that all the colonies developed on the former plates may be safely assumed to have originated from the soil in question. It must be mentioned that the developed colonies were all of identical form, presumably of the genus *Hormiscium,* of which a detailed description is given below in later paragraphs.

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[1] S. A. WAKSMAN: A Method for Counting the Number of Fungi in the Soil. Journ. Bact., Vol. 7, p. 339, 1922.

(II) *Result of the direct streak method.* The direct streak method[1] was applied to all the plots of study to test the fungal flora, the results of which are shown in Table 2.

Table 2. Filamentous Fungi found in the Solfatara Soil

Field of study	Number of plates prepared	Average Nmuber of fungal colonies per plate	Fungal species developed on the plate and the percentage of their occurrence						Calender year of study
			Hormiscium acidophilum	*Penicillium westlingi*	*Penicillium* sp.	*Trichoderma koningi*	*Aspergillus* sp.	undetermined	
A_1	5	17.0	99	0	0	0	0	1	1936
,,	5	22.4	17	82	0	0	0	1	1937
,,	5	13.8	65.2	34.8	0	0	0	0	1937
,,	4	1.25	100	0	0	0	0	0	1938
A_2	5	2.6	69.2	0	15.4	0	7.7	7.7	1938
,,	5	16.4	67.1	0	25.6	2.4	1.2	3.7	1938
A_3	5	6.6	0	0	15.1	85.0	0	0	1938
B	5	67.8	0	94.1	0	1.8	0	4.1	1936
,,	5	27.4	0	95.0	0	3	0	2	1937
,,	2	38.0	0	100	0	0	0	0	1937
,,	4	11.75	0	93.6	2.1	4.2	0	0	1938

It was shown that in the plot A_1, *Hormiscium* occupies the dominant position in the majority of cases. In one case, not a single colony of any other fungal species was detected, corroborating the result obtained by the plating method. In the plot A_2, also, *Hormiscium* was found to be dominant. In the plot A_3, colonies of *Trichoderma koningi* developed too much, so that other slowly growing fungi were difficult to demonstrate on the same plate, and it was especially so for *Hormiscium* which is remarkably slow in development. The abundance of *Trichoderma* in this plot may be attributed to the scrubs on an over-hanging cliff, from where organic fragments were profusely supplied to the plot of study. In plot B (Cladonietum), *Penicillium westlingi* was found to be dominant. Small numbers of other fungi were also detected, but no *Hormiscium* colonies were noticed.

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[1] Y. OKADA: On the Distribution of *Trichoderma* in the Soils of Various Types of Vegetation on Mt. Hakkôda. Sci Rep., Tôhoku Imp. Univ., 4 Ser., Vol. 13, p. 271, 1938.

From the above results, it may be concluded that in the highly acidic soil of the solfatara in or near the Mt. Hakkôda Botanical Laboratory, the dominant fungal species is *Hormiscium* in some cases and *Penicillium westlingi* in others. As the former may be regarded as a species new to science, a brief description is given in the following lines.

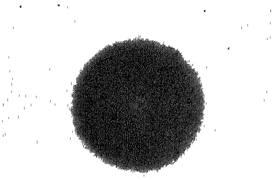
Hormiscium acidophilum

Cultural features: The fungus was inoculated on various kinds of cultural media and was incubated at a temperature of about 28°C, or at room temperature. Some of these media were found to be well fitted to the development of the fungus, but others were not.

i) a Peptone-glucose acid agar (pH 3.8–4.0). Colonies on the plate are circular, umbonate, velvety, greenish black with periphery of a little lighter colour and with deep black reverse. The growth rate is very slow, the diameter of the colony being about 5 mm in 10 days incubation at room temperature and about 18~19 mm in 10 days at about 28°C. The height of the central protruding part measures about 3 mm in the same period.

i) b Peptone-glucose acid agar (pH 2.2). The fungus grows quite well also on this highly acidic medium, the general features of the colony being almost equal to those on the above mentioned medium of lower acidity. Diameter and height of the colony in 7 days at about 28°C were 10 mm and 3 mm respectively, and the diameter in 10 days at the same temperature was 19 mm.

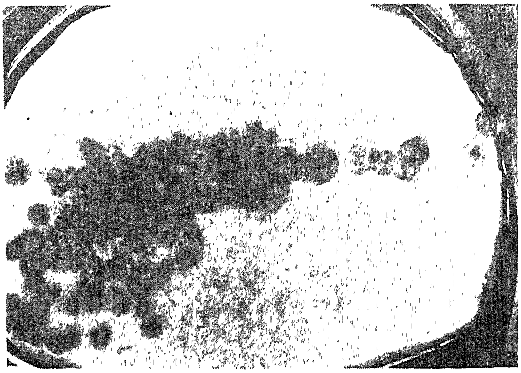
ii) Czapek's agar. General features of the colony on Czapek's agar plate (text-fig. 2) are not essentially different from those on peptone-glucose acid agar except that the height of the central part is not so prominent and the colour tone of the periphery is still lighter. Growth of the fungus is also quite slow, the diameter of the colony being about 15 mm in 10 days at 27~28°C. Growth on Czapek agar slant (Pl. V, Fig. 1) is naturally of the same features as above.


Text-fig. 2. Culture on Czapek's agar plate. 10 days at about 28°C. (Approx. nat. size)

iii) Yeast extract-peptone-glucose agar. Growth on this medium is remarkable in having a still slower rate, the colony measuring only about 3 mm wide in 10 days at 27~28°C. As for the general features of the colony, they are not different from those on Czapek's agar. Growth of slant culture (Pl. V, Fig. 2) is also very slow.

iv) Fred's mannitol agar. No growth at all.

v) Potato. The fungus grows quite well on potato plate as well as on potato plug (Text-fig. 3, Pl. V, fig. 3), and forms black circular colonies as in the case of peptone-glucose acid agar. Quite remarkable is the fact that the colonies on potato are much crowded, suggesting that the cells of the hyphae are separated easily. The growth rate is equal to that in the case of the peptone-glucose acid agar.


Text-fig. 3. Culture on potato plate. 12 days at about 28°C. (Nat. size)

vi) Broth and broth agar. No growth at all.

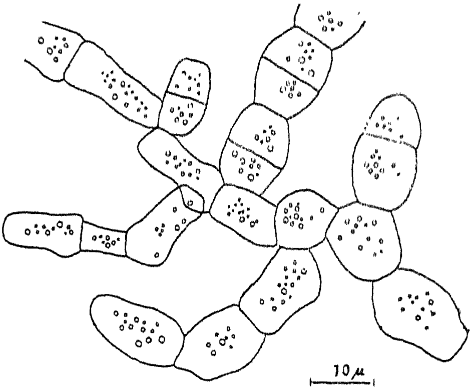
vii) Malt extract agar. Growth on this medium is almost identical to that on Czapek's agar.

viii) Starch agar. Grows very poorly. Amylase test in 10 days at about 28°C was proved to be negative.

ix) Gelatin agar. Grows very poorly. Decomposition of gelatin was tested in 5 and 10 days at about 28°C, which both proved to be negative.

x) Simple agar. Extremely poor growth was observed.

Morphology of the Cell. Morphology of the fungal cells on peptone-glucose acid agar (pH 3.8~4.0) plate is as follows (Text-fig. 4).



Text-fig. 4. Cells of a part of a well matured hypha.

The fungal cells are arranged end to end to form a chain in general, but luxurious branchings result usually in producing an irregular mass of densely anastomosing hyphae. Younger cells are transparent and colourless, and assume quite delicate filaments. Later as they grow, the colour darkens, the width increases and the length decreases (presumably a result of the new wall formation), so that the mature cells become rather short and thick with quite variable outlines, e. g., globular, ovoid, ellipsoidal, short cylindrical, pyriform, etc. The magnitude of a well developed cell attains about $8\sim 9\mu$. Surface of the cell is smooth, and walls are thin. A number of highly refracting small globules which are well stained with Sudan III are dispersed in the plasma. The cells are connected end to end quite tightly and are not easily separable.

The fungus when grown on Czapek's agar tends to produce less luxurious branching, so that the catenary arrangement of the cells is more distinct here. Outlines of the cells are usually barrel-shaped in this case and the above mentioned globular inclusions in the cells tend to be larger. Quite identical to the case on peptone-glucose acid agar is the fact that the younger cells are slender and elongated while the mature ones are short and larger.

Taxonomy of the Fungus. Taking the above cultural and morphological features into consideration, it may safely be concluded that this fungus is a member of *Dematiaceae-Toruleae-Hormiscium.* That this fungus produces only one kind of conidium, that the conidia are not easily separable and that the conidial chain is not characteristically curved, all these properties seem to justify the above conclusion. This genus, *Hormiscium* is considered to be most closely related to the genus *Torula*, the only difference being that the conidial chain is easily separable in the latter genus while the contrary is the case in the former.

The numbers of *Hormiscium* species reported up to this day[1] amount to more than 30, among which, however, some are not of very exact description and, in some cases, even the size of the cells is not given. So that it is neither an easy nor a rational task to identify the fungus in the present study with some of the species of the former report. It must be specially mentioned that all of the species heretofore described were found on plant bodies either living or dead, on leaves, trunks, branches, roots or decayed woods, the single exception being *Hormiscium aurantiacum* LINDAU which was collected on a moist tapestry. No *Hormiscium* species has ever been isolated from soil and especially from soils of such a high acidity as in the present case. From these considerations, the author considers it not unreasonable to treat this fungus as a species new to science, and proposes to give it a provisional name of *Hormiscium acidophilum.*

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[1] P. A. SACCARDO: Sylloge Fungorum. Vol. 4, p. 263, 1886; Vol. 10, p. 575, 1892; Vol. 14, p. 1070, 1899; Vol. 18, p. 567, 1906; Vol. 22, p. 1348, 1913; Vol. 25, p. 765, 1931.

Form of Living in the Natural Soil. During the past few years, the author engaged himself in a study of the microbes of the soil of Mt. Hakkôda, but he was not able to notice the occurrence of this fungus in other habitats than the acidic soils of the solfatara of Digokunuma, where it was demonstrated constantly. It was found not only constantly, but also was proved to hold the most dominant position there. This species seems to monopolize the area and is not a chance contaminant. Moreover, the cultural study shows unquestionably that this fungus well tolerates as high an acidity as pH 2.2. If properly nourished, it must grow well in the acid soil of solfatara as well. The actual form of life, however, is not easy to elucidate in the natural soil. The ROSSI-CHOLODNY method applied in the natural soil has hitherto not been satisfactory, and the question is yet to be studied.

SUMMARY

1. Filamentous fungi of the highly acidic soil of the solfatara of Mt. Hakkôda were studied by the ordinary method of plating and also by the direct streak method.

2. The number of the soil fungi of a bare plot of land near Digokunuma was reckoned by the plating method to be about 8000 per 1g of dry soil.

3. The above mentioned fungi were found to be of a single species, presumably new to science. It is quite remarkable that this species tolerates such an extreme acidity of the soil as pH 1.4.

4. This fungus, seemingly a member of *Hormiscium*, is provisionally denominated *Hormiscium acidophilum.* Descriptions of general morphological and cultural features are given.

5. The results of the direct streak method also demonstrated that the same species of fungi is dominant in the majority of cases studied. It was observed, however, that sometimes *Penicillium westlingi* assumes the most dominant position. Other species are not entirely excluded.

6. In the soil of a Cladonietum around the solfatara, also, *Penicillium westlingi* was found to be the dominant species. It is associated with *Trichoderma* and a small number of other *Penicillia.*

APPENDIX

Soil Bacteria

In order to have some knowledge about the occurrence of the ordinary peptone-decomposing bacteria in the soil of solfatara, plating study with WAKSMAN's sodium-albuminate agar[1] as culture medium was carried on with a sample of the locality A_1. The general line of the procedures practiced was the same as in the case of plating for the moulds. As for the grade of the dilution, 1/10, 1/100 and 1/1000 were applied. Few colonies of bacteria were noticed to develop on the plates. Their numbers, however, were quite approximate to those obtained on the control plates, so that positive proof of the presence of this kind of bacteria was not attained, or it may be rather safe to doubt the constancy of their occurrence in the soils of such a high acidity.

Acknowledgment. The grateful thanks of the writer are due to Prof. Dr. YOSHII, Director of Mt. Hakkôda Botanical Laboratory, and to other members there with whose cordial help these studies were carried on.

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[1] S. A. WAKSMAN: Microbiological Analysis of Soils as an Index of Soil Fertility. II. Methods of the Study of Numbers of Microorganisms in the Soil. Soil Sci., Vol. 14, p. 283, 1922; E. B. FRED and S. A. WAKSMAN: Laboratory Manual of General Microbiology. p. 9, 1928.

EXPLANATION OF THE PLATE

Fig. 1. Culture on Czapek's agar slant, 10 days at about 28°C. (natural size)

Fig. 2. Culture on Yeast water peptone glucose agar slant, 10 days at about 28°C. (natural size)

Fig. 3. Culture on potato plug, 10 days at about 28°C. (natural size)

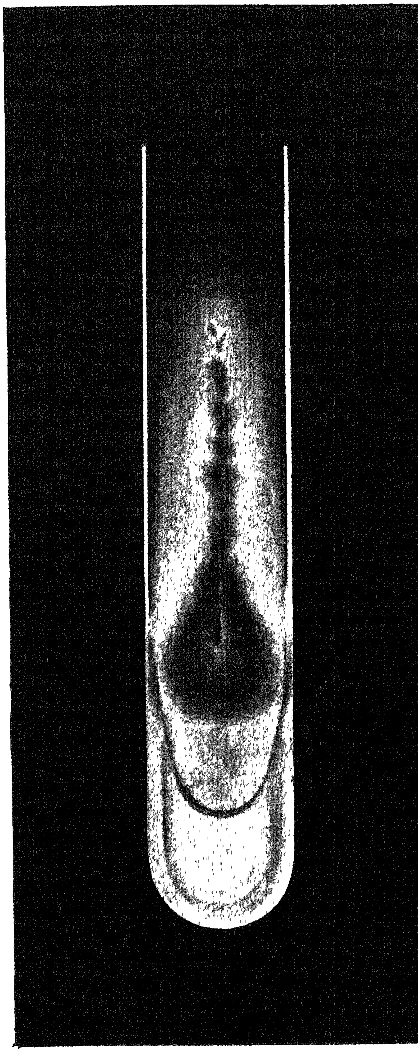

Fig. 1

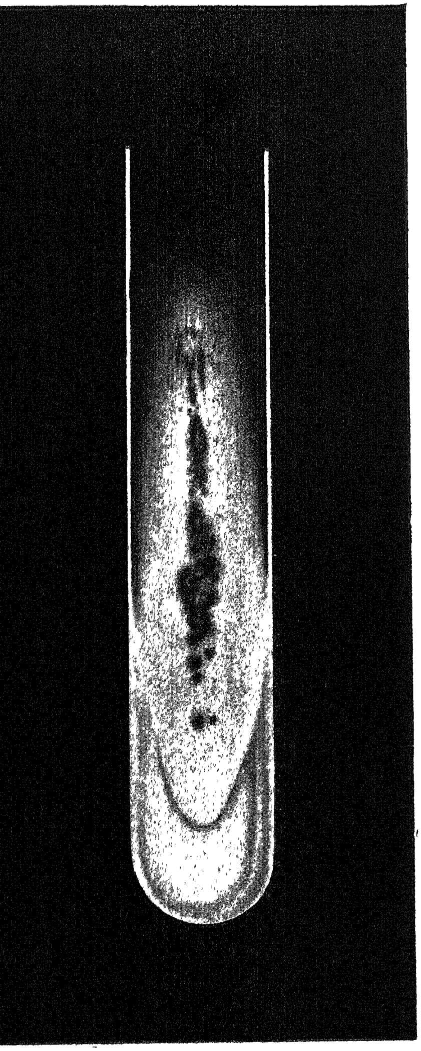

Fig. 2

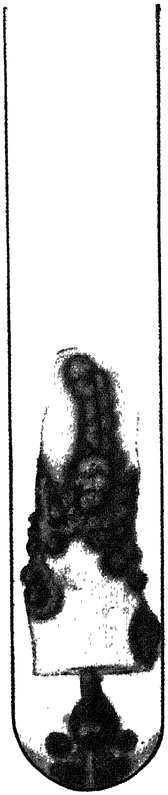

Fig. 3

K. AOYAMA del.

Y. OKADA: Filamentous Fungi of the Soil of Solfatara

REPORT ON THE CALCAREOUS SPONGES OBTAINED BY THE ZOOLOGICAL INSTITUTE AND MUSEUM OF HAMBURG
PART II

BY

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(With Pletes VI, VII and 9 Text-figures)

(Received May 7, 1942)

Some of the calcareous sponges which were contained in the collection made by the Zoological Institute and Museum of Hamburg and which were obtained from various parts of the world have already been examined by HÔZAWA and were reported in the first part of the report published in 1940. The remaining specimens of the same collection are those dealt with in the present report and they were obtained chiefly from the Strait of Magellan and its adjacent localities.

The species recorded here are 19 in number and they belong to 7 genera and 5 families. Of these forms, 13 are identical with previously known species, while the remaining 6 are here described for the first time.

The following is the list of species.

Family Homocoelidae
  1) *Leucosolenia australis* BRØNDSTED
  2) *Leucosolenia falklandica* BREITFUSS
  3) *Leucosolenia feuerlandica*, n. sp.
  4) *Leucosolenia lucasi* DENDY
  5) *Leucosolenia variabilis* HAECKEL
  6) *Dendya tripodifera* (CARTER)
Family Leucascidae
  7) *Leucetta microraphis* HAECKEL
Family Sycettidae
  8) *Sycon coronatum* (ELLIS and SOLANDER)
  9) *Sycon elegans* (BOWERBANK)
  10) *Sycon ornatum* KIRK
Family Heteropiidae
  11) *Vosmaeropsis inflata*, n. sp.

12) *Vosmaeropsis ovata*, n. sp.

Family Grantiidae

13) *Grantia genuina* ROW and HÔZAWA
14) *Leucandra astricta*, n. sp.
15) *Leucandra australiensis* (CARTER)
16) *Leucandra compacta* (CARTER)
17) *Leucandra haurakii* BRØNDSTED
18) *Leucandra reniformis*, n. sp.
19) *Leucandra uschuariensis*, n. sp.

The calcareous sponges of the Southern-hemisphere, mainly those from Australia and New Zealand have been reported on by several authors such as CARTER, LENDENFELD, DENDY, KIRK, and BRØNDSTED. However concerning the *Calcarea* of the southern part of South America, no report has hitherto been made, except for the paper by RIDLEY (1881) recording only six species. It seems, therefore, very interesting to compare the fauna of the *Calcarea* with that of the other districts.

As is seen from the above list, the number of species obtained in the neighbourhood of the Strait of Magellan is 19, and thus the collection made by the Zoological Institute and Museum of Hamburg contained 32 species in all when those recorded in the first part of the present study are added.

Here I should like to express my hearty thanks to Prof. SANJI HÔZAWA for so kindly allowing me to examine this collection and for his valuable advice rendered during the course of the study.

Family Homocoelidae DENDY

Genus **Leucosolenia** BOWERBANK

1) *Leucosolenia australis* BRØNDSTED

Leucosolenia australis, BRØNDSTED, 1928, p. 15, text-figs. 15, 16; TANITA, 1942, p. 84.

Two small specimens in the collection have been assigned to this species. They are all fragmental. One specimen represents an anastomosing loose net-work of Ascon-tubes, but being crushed by a foreign object, the minute structure could not be examined except for the shape of the spicules. The other specimen is a small fragment, consisting of two branched Ascon-tubes.

The Ascon-tubes of the sponge are nearly cylindrical with diameter of about 1 mm. The surface of the tubes is minutely hispid on account of projecting oxea. The colour in alcohol is white and the texture is fragile.

The arrangement of skeleton and the spiculation of the present specimens are entirely identical with those mentioned in the original description given by BRØNDSTED.

Previously known Distribution: — Observatory Bay, Kergulen (BRØNDSTED).

Locality: — Strait of Magellan.

2) *Leucosolenia falklandica* BREITFUSS

(Pl. VI, fig. 1)

Leucosolenia falklandica, BREITFUSS, 1898, p. 458, Taf. 27, figs. 3, 4; 1897, p. 211; DENDY and ROW, 1913, p. 725; BURTON, 1934, p. 8; TANITA, 1942, p. 79.

A single specimen of this species occurs in the collection. The sponge (Pl. VI, fig. 1) forms a low-growing, much flattened, spreading loose net-work of Ascon-tubes. On its upper surface, occur a number of small conical papillae, some being provided with a minute osculum at their apex. At one end of the colony a large Ascon-tube projects freely which has a thickness of 2.5 mm. The whole colony measures about 15 mm in breadth. The colour of the specimen in spirit is nearly white and the texture is soft.

Previously known Distribution: — Falkland Island (BREITFUSS, BURTON).

Locality: — Uschuaria, near the Strait of Magellan.

3) *Leucosolenia feuerlandica*, n. sp.

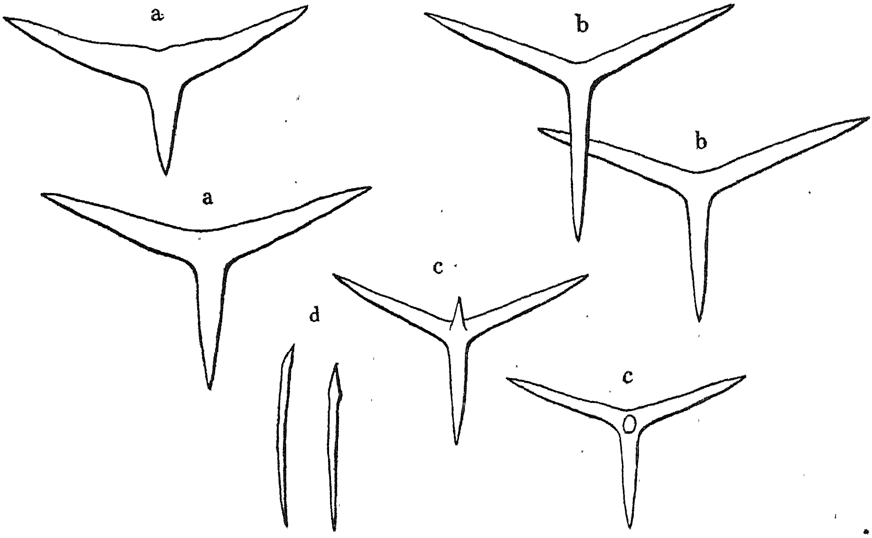
(Pl. VI, fig. 2; text-fig. 1)

This new species is based upon a single specimen in the collection. The sponge (Pl. VI, fig. 2) forms a much flattened, spreading mass of branching and copiously anastomosing Ascon-tubes. It is found growing over algae, and is irregular in outline and measures about 7 mm in length by 8 mm in greatest breadth.

The outer surface of the sponge appears slightly hispid and uneven when observed under the hand-lens. The pseudopores are thickly distributed on the pseudoderm, varying in size up to about 1 mm in diameter, and are mostly of oval shape. The colour in alcohol is white.

Structure: — The skeleton is composed of triradiates, quadriradiates, and of oxea. The outer surface of the colony is strengthened by a single layer of spicules of somewhat stouter rays than those found in the interior of the sponge. The tri- and quadriradiates are arranged irregularly in several layers in the sponge wall. The apical rays of the latter kind of spicules project freely into the gastral cavity. The oxea occur here and there standing at right angles from the sponge wall and thus they give to the surface of the tube the hispid appearance.

Spicules (Text-fig. 1): — Triradiates of pseudoderm (a) sagittal and look like the so-called „ Tripod " spicules in shape. Basal ray straight, tapering to sharp end, shorter than paired rays, 50–70 μ long and 12–18 μ thick at base. Paired rays equal, widely divergent, not even in outline, slightly curved forwards, 70–95 μ long and 12–18 μ thick at base.



Text-fig. 1. *Leucosolenia feuerlandica*, n. sp. a, triradiates of pseudoderm; b, triradiates of deep portion; c, quadriradiates of the same; d, oxea. (all ×300)

Triradiates from the deep portion of the body (b) slightly sagittal. All rays are slender and are of same thickness being 8–10 μ. Basal ray straight, slightly shorter than paired rays with length of 60–70 μ. Paired rays equal, straight, sharply pointed being 75–90 μ long.

Quadriradiates from the deep portion of the body (c) similar to the triradiates of the same, only differing in the presence of apical ray. Apical ray straight, sharply pointed, shorter and slightly thinner than facial rays, 40–50 μ long and 6–8 μ thick at base.

Oxea (d) spindle-shaped, either nearly straight or slightly curved, sharply pointed at both ends, 70–90 μ long and 4–6 μ thick in the thickest parts.

Remarks: — This species bears a close resemblance to *Leucosolenia botryoides* var. *macquariensis*[1] which was reported from the Macquarie Island by DENDY in 1918, but it may be easily distinguished from the latter by the presence of tripod-like spicules in the pseudoderm which is entirely wanted in DENDY's species.

Locality: — Feuerland, South America.

4) *Leucosolenia lucasi* DENDY

(Pl. VI, fig. 3)

Leucosolenia lucasi, DENDY, 1891, p. 45. Pl. 1, fig 1, Pl. 4, fig. 1, Pl. 9, fig. 1; KIRK, 1893, p. 178, Pl. 23, fig. 2; TOPSENT, 1907, p. 539; BRØNDSTED, 1926, p. 298, fig. 1; ROW and HÔZAWA, 1931, p. 729; TANITA, 1942, p. 85.

Leucosolenia bella, DENDY and ROW, 1913, p. 721.

This species is represented by five well-developed specimens consisting of a mass of branching Ascon-tubes.

The largest specimen (Pl. VI, fig. 3) forms a massive colony attaining a height of 20 mm and a breadth of 40 mm. The Ascon-persons are of small size, being cylindrical and thin-walled, measuring 3 mm in length and from 0.4 to 1 mm in diameter. The osculum at each upper end is difficult to observe with the naked eye.

The remaining specimens are colonies composed of more loosely branched tubes than the largest one.

The stolon is hardly visible on any of the specimens, as each of them forms a massive colony. The skeleton consists of sagittal tri- and quadriradiates and of oxea. With regard to the arrangement of the skeleton, canal system, and spiculations, DENDY already stated fully in his original description. The shape and dimensions of the spicules of the present specimens are identical with those given in DENDY's description.

Previously known Distribution: — Port Phillip Heads (DENDY); Cook Strait, N. Z. (KIRK); Pegasus Bay, Stewart Island, N. Z. (BRØNDSTED); Geraldton District, Albany District (ROW and HÔZAWA).

Locality: — Uschuaria, near the Strait of Magellen.

5) *Leucosolenia variabilis* HAECKEL

Leucosolenia variabilis, HAECKEL, 1870, p. 243; MINCHIN, 1905, p. 373, text-figs. 94–96; DENDY and ROW, 1913, p. 723; BREITFUSS, 1927, p. 28; 1932, p. 243; TANITA, 1942, p. 83.

Ascandra variabilis, HAECKEL, 1872, p. 106, Taf. 16, fig. 4; BREITFUSS, 1897, p. 215;

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[1] *Leucosolenia botryoides* var. *macquariensis* DENDY, 1918, pp. 5–7, Pl. I, figs. 1, 6a–6e.

1898, p. 16, 98, p. 23; Arnesen, 1900, p. 15; Lundbeck, 1909, p. 549.

This species is represented by five specimens in the collection. Each of them shows a nearly similar appearance, consisting of a loose colony of branching and anastomosing Ascon-tubes. The Ascon-persons are small, being cylindrical and thin-walled tubes, 5–15 mm in height and about 1.5 mm in diameter. There is a circular osculum at the summit of each fully grown individual. The outer surface of the tubes appears to be minutely hispid to the naked eye and the colour in spirit is white.

The external and internal features of the specimens seem to agree well with the descriptions and figures of this species made by Haeckel and Minchin.

Previously known Distribution: — Atlantic Ocean.

Localities: — Uschuaria, Near the Strait of Magellen; Iquique, Chile.

Genus **Dendya** Bidder

6) *Dendya tripodifera* (Carter)

Clathrina tripodifera, Carter, 1886, p. 505.
Leucosolenia tripodifera, Dendy, 1891, p. 66, Pl. 2, figs. 5, 6, Pl. 5, figs. 3, 4, Pl. 8, figs. 5, 6, Pl. 11, fig. 5.
Dendya tripodifera, Bidder, 1898; Dendy and Row, 1913, p. 728.

This interesting species is represented by a single specimen. in the collection. As the specimen at hand is a small fragment, the writer was not able to compare the external features with the original description of this species except for the pseudoderm. However, the canal system, skeletal structures, and the spicules of the present specimen agree so well with the descriptions and figures of previous writers, that I have no hesitation in making a specific identification.

The specimen which has come into my hand is a flattened mass of anastomosing Ascon-tubes, being about 8 mm in length and 3.5 mm in breadth. The colour in alcohol is nearly white.

Previously known Distribution: — Port Phillip Heads (Carter, Dendy); Westernport, Kent Island (Dendy).

Locality: — South Georgia Island.

Family Leucascidae HAECKEL

Genus Leucetta HAECKEL

7) *Leucetta microraphis* HAECKEL

(Pl. VI, fig. 4)

Leucetta primigenis var. *microraphis*, HAECKEL, 1872, p. 119, Taf. 21, figs. 10–17.
Leucetta microraphis, RIDLEY, 1884, p. 482; von LENDENFELD, 1885, p. 117; DENDY and ROW, 1913, p. 734; DENDY and FREDERICK, 1924, p. 482; ROW and HÔZAWA, 1931, p. 746.
Leuconia dura, POLÉJAEFF, 1888, p. 65.
Leucandra microraphis, DENDY, 1892, p. 104.
Leucandra primigenea var. *microraphis*, ROW, 1909, p. 186.

A single specimen (Pl. VI, fig. 4) from Abrolhos Island, Brazil, is assigned to this well-known species. The sponge forms an elongated but strongly laterally compressed irregular mass, attaining the height of 15 mm, the breadth of 27 mm, and the thickness of 8 mm. Two naked oscula are seen at the upper end of the sponge, one of which is elliptical in form measuring 4 × 2 mm and the other is very small. The colour in spirit is white and the texture is very hard.

Previously known Distribution: — Australia? (HAECKEL); North Coast of Australia, Torres Straits (RIDLEY, POLÉJAEFF); East Coast of Australia, Port Jackson; South Coast of Australia, near Port Phillip Heads (LENDENFELD, DENDY); Red Sea (ROW); Off Bermudas (POLÉJAEFF); Abrolhos Islands, Western Australia (DENDY and FREDERICK); Shark's Bay District, Geraldton District, Bunbury District (ROW and HÔZAWA).

Locality: — Abrolhos Island, Brazil.

Family Sycettidae DENDY

Genus Sycon RISSO

8) *Sycon coronatum* (ELLIS and SOLANDER)

(Pl. VI, fig. 5)

Spongia coronata, ELLIS and SOLANDER, 1785, p. 190, Tab. 58, figs. 8, 9.
Sycandra coronata, HAECKEL, 1872, p. 304, Taf. 51, fig. 2, Taf. 60. figs. 1–6.
Sycon coronatum, DENDY, 1892, p. 79; DENDY and ROW, 1913, p. 745; LAUBENFELS, 1932, p. 11; BREITFUSS, 1935, p. 16; HÔZAWA, 1940, p. 140, Pl. 6, fig. 5, text-fig. 4; TANITA, 1941, p. 2.

The collection contains four specimens of this well-known species which were taken from three different localities.

The largest specimen (Pl. VI, fig. 5) which came from Feuerland is ovoid in shape and is provided with a well-developed oscular collar at the upper end. The sponge is 8 mm high and 6 mm in diameter. The osculum is circular in shape with a diameter of 1.5 mm. The oscular collar is about 2 mm high. The dermal surface is strongly hispid owing to the projecting tufts of long oxea at the distal ends of flagellated chambers.

The remaining three specimens are smaller than the above mentioned specimen and are more or less elongated in shape.

On the structures and spiculations, the species has been fully described by HÔZAWA in the first part of this paper, so that no further details are necessary.

Previously known Distribution: — East coast of Australia (HAECKEL, LENDENFELD, DENDY); Atlantic Ocean (HAECKEL, BREITFUSS); Pacific Ocean (HAECKEL); Indian Ocean (ROW); Messina (HÔZAWA); Mutsu Bay (TANITA).

Localities: — Feuerland; Uschuaria; Punta Arenas, Chile.

9) *Sycon elegans* (BOWERBANK)

(Pl. VI, fig. 6)

Dunstervillia elegans, BOWERBANK, 1845, p. 297, Pl. 17.
Grantia tessellata, BOWERBANK, 1866, p. 26.
Dunstervillia tessellata, GRAY, 1867, p. 557.
Sycum tessellatum, HAECKEL, 1870, p. 239.
Dunstervillia Lanzerotae, HAECKEL, 1870, p. 240.
Dunstervillia formosa, HAECKEL, 1870, p. 240.
Sycandra elegans, HAECKEL, 1872, p. 338, Pl. 54, fig. 3, Pl. 58, fig. 3.
Sycon elegans, DENDY and ROW, 1913, p. 745.

Only a single specimen (Pl. VI, fig. 6) of this interesting species exists in the collection. The sponge is of an oval form and is attached to the foreign object by its base directly. It is about 7 mm. high and 3 mm. broad in the middle parts of the body. At the upper end of the sponge, there is found an osculum surrounded by two sorts of well-developed collars, one spreading horizontally, and the other disposed vertically forming an oscular fringe. The oscular collar is about 2.5 mm. high. The body wall is 1 mm. thick in the middle parts. The dermal surface is hispid owing to the projecting oxea, while the gastral appears nearly smooth to the naked eye. The colour in spirit is yellowish white.

This species may be easily distinguished from other members of the genus by the rod-like oxea, the particularly stout and strong sagittal spicules found at the distal end of flagellated chambers, and by the presence of an oscular collar in horizontal position.

Proviously known Distributions : — Mediterranean Sea ; Canary Island; Coast of Portugal ; Coast of South Africa.

Locality : — Arrabida, Serrada Portugal.

10) *Sycon ornatum* KIRK

(Pl. VI, fig. 7)

Sycon ornatum, KIRK, 1897, p. 314, Pl. 31, fig. 2, Pl. 32, fig. 2; DENDY and ROW, 1913, p. 747; BRØNDSTED, 1926, p. 303; HÔZAWA, 1940, p. 36; TANITA, 1941, p. 269.

Only a single specimen of this species is contained in the collection. It (Pl. VI, fig. 7) represents a solitary individual of an elongated cylindrical form, broadest near the base and shows at the upper end an osculum surrounded by a well-developed delicate collar. The total length of the sponge is 11 mm and the greatest breadth is 4 mm. The osculum is nearly circular in shape with a diameter of 1 mm and the oscular collar measures 1.5 mm in hight. The colour in alcohol is dirty yellow.

Remarks : — This species was first described by KIRK (1897), using a single specimen obtained from Cook Strait, New Zealand. The second occurrence of this species was reported in 1926 by BRØNDSTED from the same locality, and after that it was reported by HÔZAWA in 1940 and by TANITA in 1941 from the Japanese waters.

Previously known Distribution : — New Zealand (KIRK, BRØNDSTED) ; Rikuzen Ohshima (HÔZAWA) ; Onagawa Bay (TANITA).

Locality : — Punta Arenas, Strait of Magellen.

Family Heteropiidae DENDY

Genus **Vosmaeropsis** VON LENDENFELD

11) *Vosmaeropsis inflata*, n. sp.

(Pl. VI, fig. 8; text-fig. 2)

Only a single specimen (Pl. VI, fig. 8) of this new species exists in the collection. It is a solitary individual with irregular outline, more or less dorso-ventrally compressed, attached by the base and provided with an osculum on the upper surface. The sponge measures 8 mm in height, 12 mm in greatest breadth and 7.5 mm in thickness. The osculum is naked and irregular in shape. The dermal surface is nearly smooth but uneven. The gastral cavity is comparatively narrow and is branched in an irregular manner.

The colour in spirit is yellowish white and the texture is rather soft.

Structure: — The canal system is leuconoid. The flagellated chambers are thickly distributed between the well-developed inhalant and exhalant canal systems. They are ovoid or spherical in form with a diameter of about 100 μ.

The dermal skeleton is thin, composed of a few layers of dermal triradiates and of paired rays of subdermal pseudosagittal triradiates. The latter kind of spicules are not to be clearly distinguished from the tubar triradiates. Underneath the dermal surface there exist subdermal cavities.

The chamber layer is perforated by large inhalant and exhalant canals and the skeleten of which is made up of irregularly arranged tubar triradiates and of basal rays of subdermal pseudosagittal triradiates. Here and there a number of large oxea are found occurring close to the dermal surface but never projecting from it.

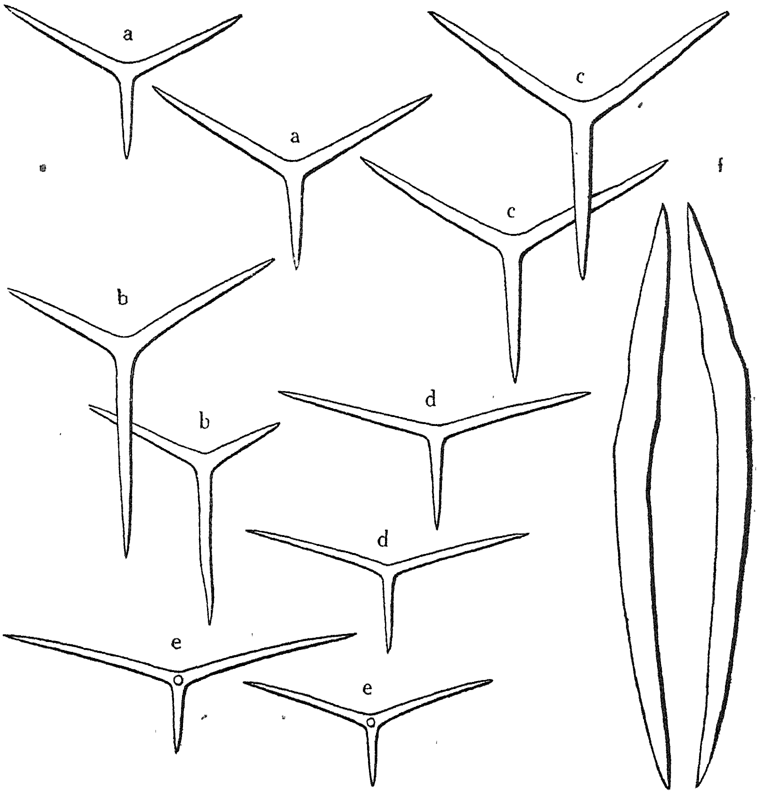
The gastral skeleton is thinner than the dermal and is composed of tangentially placed gastral tri- and quadriradiates. The short apical rays of quadriradiates project into the gastral cavity. The skeleton of oscular margin is made up of large oxea, of triradiates, and of quadriradiates. The spicules found on the dermal side are dermal triradiates and large oxea, while those on the gastral are tri- and quadriradiates with wide oral angles.

Spicules (Text-fig. 2): — Dermal triradiates (a) sagittal. Basal ray straight, distinctly shorter than paired rays, 130–210 μ long and 18–23 μ thick at base. Paired rays equal, nearly straight, taper to sharp end, 200–265 μ long and 18–23 μ thick at base.

Subdermal triradiates (b) pseudosagittal. Basal ray nearly straight and slightly crooked nearer the sharply pointed end, longer than paired rays, 230–300 μ long and 20–25 μ thick at base. Paired rays unequal; the longer ray are gently curved backwards, 180–260 μ long, the shorter ray straight, sharply pointed, 150–225 μ long and the both 20–25 μ thick at base.

Tubar triradiates (c) slightly sagittal. Basal ray straight, tapering to a sharp point, 250–310 μ long and 25–34 μ thick at base. Paired rays nearly equal, slightly longer than basal ray, 280–330 μ long and 25–34 μ thick at base.

Gastral triradiates (d) strongly sagittal. Basal ray straight, much shorter than paired rays, 90–140 μ long and 12–15 μ thick at base. Paired rays



Text-fig. 2. *Vosmaeropsis inflata*, n. sp. a, dermal triradiates; b, subdermal triradiates; c, tubar triradiates; d, gastral triradiates; e, gastral quadriradiates; f, large oxea. (all ×100)

equal, widely divergent, 190–260 μ long and 12–15 μ thick at base.

Gastral quadriradiates (e) like the gastral triradiates except for the presence of apical ray. Apical ray short, sharply pointed, thinner than facial rays, 80–130 μ long and 8–10 μ thick at base.

Tri- and quadriradiates of the oscular margin similar to those of the gastral skeleton.

Large oxea (f) spindle-shaped, uneven in outline, sharply pointed at both ends, curved irregularly near the distal end, measuring up to 800 μ by 55 μ.

Remarks: — This species has sparce but peculiarly curved large oxea. By these oxea and by external features, it may be distinguished from other members of the section in the genus which are charged with large oxea but lacking microxea.

Locality: — Punta Arenas, Chile.

12) *Vosmaeropsis ovata*, n. sp.

(Pl. VI, fig. 9; text-fig. 3)

The collection contains four specimens of the new species which were collected from Sarmiento, Chile. All specimens are solitary and more or less irregularly massive attached to some sea weeds. I have selected the largest specimen (Pl. VI, fig. 9) as the type on which to base further description.

It is oval in shape, being 18 mm long and 12 mm in diameter. The sponge wall is about 3.5 mm thick in the middle parts. The osculum is naked and is elliptical in shape with a diameter of 1.8–2.5 mm. Both the dermal and gastral surfaces appear smooth to the naked eye but the gastral surface is perforated by numerous exhalant apertures of varying sizes.

The colour in alcohol is white and the texture is not very firm but rather elastic.

Structure: — The canal system is of the leuconoid type. The flagellated chambers are of nearly oval form with maximum diameter of 60–90 μ.

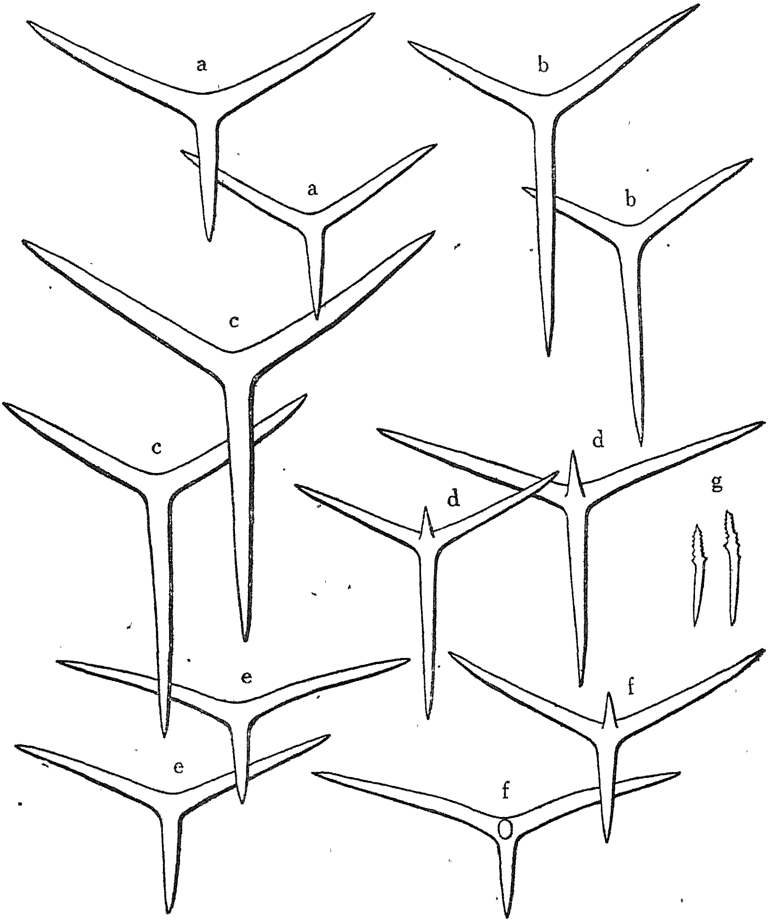
The dermal skeleton is composed of several layers of tangentially placed triradiates and of paired rays of subdermal pseudosagittal triradiates. Amongst these spicules microxea are distributed at various angles to the dermal surface. Underneath the dermal cortex there exist subdermal cavities of varying sizes.

The chamber layer is strongly lacunar on account of the well-developed inhalant and exhalant canals. The skeleton of the chamber layer is made up chiefly of tubar triradiates with admixture of basal rays of subdermal pseudosagittal triradiates and of a few quadriradiates which occur along the larger exhalant canals. The basal rays of subgastral triradiates may be added to the skeleton.

The gastral skeleton is thinner than the dermal, consisting of a few layers of tri- and quadriradiates. The oscular margin is a continuation of dermal and gastral skeleton and thus there are no special spicules to be mentioned.

Spicules (Text-fig. 3): — Dermal triradiates (a) sagittal. Basal ray straight, gradually and sharply pointed, shorter than paired rays, 130–170 μ long and 12–15 μ thick at base. Paired rays equal, gently curved forwards, 140–180 μ long and 12–15 μ thick at base.

Subdermal triradiates (b) pseudosagittal. All rays are different in length but equal in thickness being 15–20 μ. Basal ray straight, sharply pointed, longer than paired rays being 170–230 μ. Longer oral ray either straight or slightly curved, measuring 130–180 μ in length. Shorter ray straight, sharply pointed at end and 90–130 μ long.



Text-fig. 3. *Vosmaeropsis ovata,* n. sp. a, dermal triradiates; b, subdermal triradiates; c, tubar triradiates; d, quadriradiates of larger exhalant canal; e, gastral triradiates; f, gastral quadriradiates; g, dermal microxea. (a–f ×150; g ×240)

Tubar triradiates (c) sagittal. Basal ray straight, longer than paired rays, 200–280 μ long and 18–22 μ thick at base. Paired rays nearly equal, more or less curved forwards, 180–230 μ long and 18–22 μ thick at base.

Quadriradiates of larger exhalant canals (d) sagittal and all rays are not in one plane. Basal ray straight, tapers to sharp end, 160–200 μ long and 12–16 μ thick at base. Paired rays equal, nearly straight, sharply pointed, slightly shorter than basal ray, 150–185 μ long and 12–16 μ thick at base. Apical ray slightly curved oralwards, fairly finely pointed, shorter and thinner than facial rays, 95–125 μ long and about 10 μ thick at base.

Gastral triradiates (e) strongly sagittal. Basal ray straight, much shorter than paired rays, 120–160 μ long and 12–18 μ thick at base. Paired rays nearly equal, more or less curved, widely divergent, 220–250 μ long and 12–18 μ thick at base.

Gastral quadriradiates (f) exactly similar to triradiates of the same, only differing in having an apical ray. Apical ray curved upwards, sharply ended, 70–130 μ long and 10–14 μ thick at base.

Dermal microxea (g) slightly curved, sharply pointed at both ends, one of which is solely pointed while the other is provided with numerous spine-like protuberances. They are 60–80 μ long and 4–6 μ thick.

Remarks: — The present species can not be identified with any previously known species. The most conspicuous features of this species exists in the presence of dermal microxea and in lacking of large oxea. In the genus *Vosmaeropsis* no member which charged with only microxea has been hitherto known.

Locality: — Sarmiento, Chile.

Family Grantiidae DENDY

Genus **Grantia** FLEMING

13) *Grantia genuina* ROW and HÔZAWA

(Pl. VII, fig. 10)

Grantia genuina, ROW and HÔZAWA, 1931, p. 781, Pl. 20, fig. 12, text-fig. 11.

This species is represented by a single specimen (Pl. VII, fig. 10) in the collection. It is of a cylindrical form, measuring 8 mm. in height and about 2 mm. in diameter. The surface of the body is hispid owing to the projecting large oxea. The osculum at the upper end is provided with a fringe consisting of linear spicules.

The species has been fully recorded by previous authors, so that no further details are necessary to be added.

Previously known Distibution: — Shark's Bay District, Australia (ROW and HÔZAWA).

Locality: — Strait of Magellan.

Genus **Leucandra** HAECKEL

14) *Leucandra astricta*, n. sp.

(Pl. VII, fig. 11; text-fig. 4)

Eighteen specimens of this new species exist in the collection. They are variable in length ranging from 6 mm. to 36 mm. They are also variable in shape, each appearring as if a small rounded rock. To base further description on, I have selected the largest specimen shown in Pl. VII, fig. 11.

The sponge is a solitary person of an elongated elliptical massive shape, attached by its base to the substratum directly. It measures 36 mm. in length, 18 mm. in breadth and 15 mm. in thickness. There are five naked oscula, four of which are small while the remaining one is large and irregular in shape with a maximum diameter of 8 mm. The dermal surface is nearly smooth to the naked eye but uneven in outline. The gastral cavity is relatively narrow and is branched in an irregular manner. The surface of the gastral cavity appears smooth.

The colour in the preserved state is dirty white and the texture is very firm.

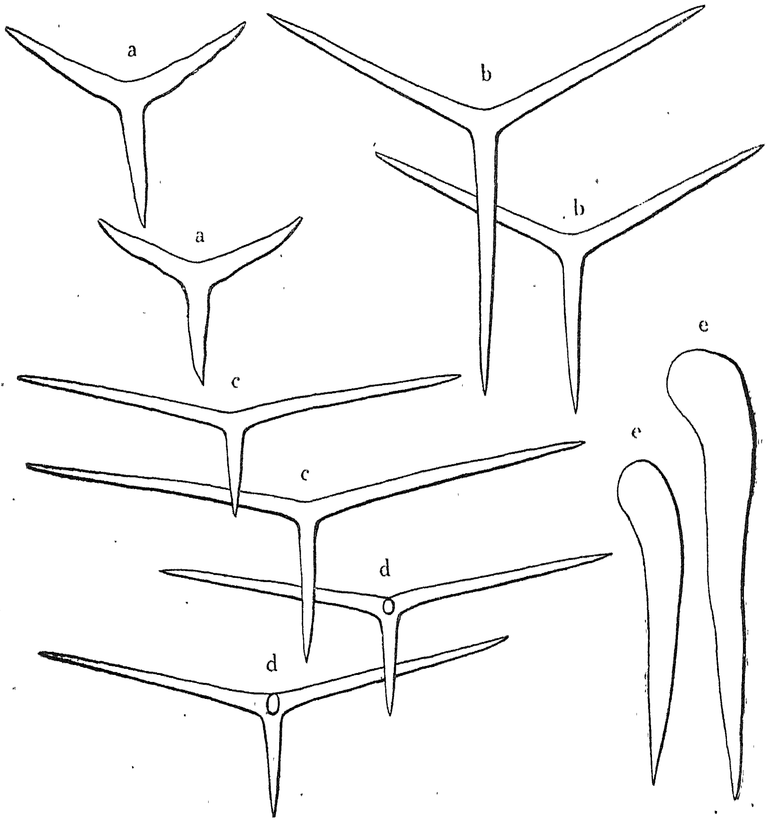
Structure: — The canal system is typical. The flagellated chambers are of spherical or nearly so with a diameter of 60–90 μ and are closely set together in the chamber layer.

The dermal skeleton is rather thin, composed of a few layers of tripod-like dermal triradiates and of distal parts of oxea. The proximal parts of oxea are deeply implanted in the body wall while the round distal are arranged densely and thus forms a dermal cortex together with the tangentially placed triradiates.

The skeleton of chamber layer is chiefly made up of irregularly and densely distributed tubar triradiates. Near the dermal surface, the tubar skeleton is added the proximal parts of large oxea. The gastral skeleton is fairly well distinguishable from that of the chamber layer, consisting of several layers of gastral triradiates and quadriradiates. Both are arranged tangentially and their basal rays are pointed downwards in most cases.

The oscular margin does not show any special skeleton to be mentioned. It is composed of one kind of gastral spicules with wide oral angles.

Spicules (Text-fig. 4): — Dermal triradiates (a) slightly sagittal but nearly equiradiates. All rays stout, with more or less undulated outline and show a tripod-like appearance. Basal ray sharply pointed, either



Text-fig. 4. *Leucandra astricta*, n. sp. a, dermal triradiates; b, tubar triradiates; c, gastral triradiates; d, gastral quadriradiates; e, large oxea. (all × 150)

equal to or very slightly shorter than paired rays, 110–130 μ long and 20–22 μ thick at base. Paired rays nearly equal, slightly curved forwards, 120–150 μ long and 20–22 μ thick at base.

Tubar triradiates (b) subregular or slightly sagittal. Basal ray straight, tapering to sharply pointed end, 170–200 μ long and 14–18 μ thick at base. Paired rays equal, straight, sharply pointed, 190–220 μ long and 14–18 μ thick at base.

Gastral triradiates (c) strongly sagittal. All rays slender and nearly equal in thickness being 10–14 μ. Basal ray straight, much shorter than paired rays being 100–110 μ long. Paired rays equal, widely divergent and are 200–220 μ long.

Gastral quadriradiates (d) like the gastral triradiates, except for the presence of an apical ray. Apical ray short, sharply pointed, 45–50 μ long and about 12 μ thick at base.

Oxea (e) stout, club-shaped and more or less curved. The proximal end pointed sharply while the distal swells and forms a round head. They measure 210–380 μ in length and 40–70 μ in thickness of the head.

Remarks: — The present new species may belong to Section A of the genus *Leucandra* in the system of classification proposed by DENDY and ROW[1], on account of the fact that it is charged with radially arranged large oxea but lacking microxea. But this species has two remarkable characteristics, viz. 1) the existence of the dermal triradiates resembling tripod spicules and 2) the same of the large club-shaped oxea. On these points it may be easily distinguished from the other members of the genus.

Locality: — South Georgia Island.

15) *Leucandra australiensis* (CARTER)

(Pl. VII, fig. 12; text-fig. 5)

Leuconia fistulosa var. *australiensis*, CARTER, 1886, p. 127.

Leucandra australiensis, DENDY, 1892, p. 97; DENDY and ROW, 1913, p. 769; BRØNDSTED, 1926, p. 312, text-fig. 9.

This species is represented by nineteen specimens in the collection. They are variable in length ranging from 10 mm. to 35 mm. and are variable in shape as well. Some of the specimens are sac-like in form and the others are of elongate tube-like. Each of the specimens is solitary and shows an osculum at its upper end which is surrounded by a short oscular collar.

The largest specimen (Pl. VII, fig. 12), upon which the further descriptions are based, is of a tubular form, slightly compressed, broadest near the base and gradually narrowing towards the upper osculum which is damaged. It is about 35 mm. long and 18 mm. broad at the broadest parts. The osculum is not perfect and is of an elliptical in form with diameters of 6 × 3.5 mm.

The dermal surface is more or less hispid owing to the projecting oxea and the gastral surface is also hispid on account of the presence of apical rays of gastral quadriradiates. The gastral cavity is relatively narrow and is branched irregularly.

The oscular margin is provided with a short peristome in most specimens, but in the case of the largest one it appears to be naked, the oxeote spicules being cut off short.

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[1] DENDY and ROW, 1913, Proc. Zool. Soc. London, p. 769.

The colour in alcohol is nearly white with faint yellowish tint. The texture is not very firm but elastic.

Structure: — The canal system is leuconoid. The flagellated chambers are of an oval shape or nearly so with diameter of 100–200 μ and are rather irregularly distributed in the chamber layer. Beneath the dermal cortex, there exist subdermal cavities of various sizes.

The dermal skeleton is rather thin, composed of a few layers of triradiates arranging tangentially. Large oxea project from the dermal surface to some extent distally. The skeleton of chamber layer is made up of irregularly scattered tubar triradiates and of the proximal parts of large oxea.

The gastral skeleton is as thick as the dermal and is consisted of tangentially placed gastral tri- and quadriradiates. The basal rays of these radiates are directed downwardly in most cases and the short apical rays of gastral quadriradiates projected into the gastral cavity. The skeleton of the oscular margin is composed of linear spicules and of gastral radiates with wide oral angles. The former kind of spicules are disposed longitudinally and run parallel with one another.

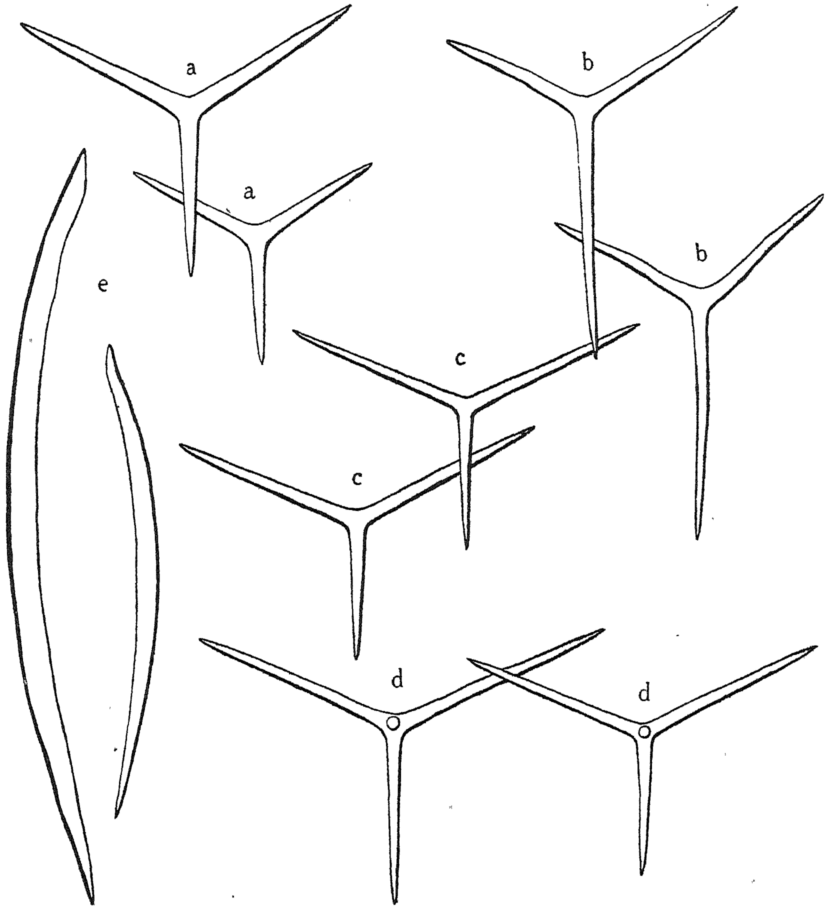
Spicules (Text-fig. 5): — Dermal triradiates (a) subregular or very slightly sagittal. Basal ray straight, tapering to sharp end, 170–240 μ long and 10–13 μ thick at base. Paired rays equal, nearly straight, either equal to or slightly longer than basal ray, 170–260 μ long and 10–13 μ thick at base.

Tubar triradiates (b) sagittal. Basal ray straight, longer than paired rays, sharply pointed, 180–300 μ long and 12–20 μ thick at base. Paired rays equal, slightly curved forwards, 170–240 μ long and 12–20 μ thick at base.

Gastral triradiates (c) also sagittal. All rays are equal in thickness being 8–10 μ. Basal ray straight, tapering to sharp end, shorter than paired rays being 220–280 μ long. Paired rays nearly equal, widely divergent and are 240–290 μ long.

Gastral quadriradiates (d) similar to the triradiates of the same portion, except for the presence of an apical ray. Apical ray slightly curved oralwards, shorter and thinner than facial rays, 65–100 μ long and about 8 μ thick at base.

Oxea (e) elongate spindle-shaped, more or less curved, tapering towards the both ends, measuring 380–860 μ in length and 23–35 μ thick in the thickest parts.



Text-fig. 5. *Leucandra australiensis* (CARTER). a, dermal triradiates; b, tubar triradiates; c, gastral triradiates; d, gastral quadriradiates; e, oxea. (all ×100)

Remarks: — The writer has identified the specimens at hand with this species for their external and internal features seem to agree well with the descriptions made of this species by previous writers.

This species was first described by CARTER in 1886, basing upon the materials obtained from New Zealand. But he did not give any drawing of the spicules. Since that time, DENDY has also recorded this species from the same locality, but also without giving any figures. In 1926, this species was recorded by BRØNDSTED showing a drawing of spicules. The writer, therefore, appended here a photograph of the spicimen and the figures of all kinds of spicules.

Previously known Distribution: — Near Port Phillip Head (CARTER, DENDY); Little Barrier Island, N. Z. (BRØNDSTED).

Localities: — Uschuaria, near the Strait of Magellan; South Georgia Island.

16) *Leucandra compacta* (CARTER)

(Pl. VII, fig. 13; text-fig. 6)

Leuconia compacta, CARTER, 1886, p. 144.
Leucandra compacta, DENDY, 1892, p. 100; DENDY and ROW, 1913, p. 770.

Eight specimens in the collection have been assigned to this species. They are variable in shape and in size but are all alike in being solitary and appearing very compact. The largest specimen (Pl. VII, fig. 13) was chosen as the base for further description.

The sponge is of an irregularly oval shape, more or less laterally compressed, broadest at the base and tapers towards the upper osculum. It measures 16 mm. in height and 19 mm. in greatest breadth, the wall being about 5 mm. in thickness. The osculum at the upper end is nearly naked and is circular in shape with a diameter of 2 mm. The dermal surface is more or less uneven and is slightly hispid on account of the projecting large oxea. The gastral cavity is branched irregularly. The surface of the gastral cavity is perforated by a great number of irregularly distributed circular or oval exhalant apertures and appears slightly hispid under the hand-lens owing to the projecting apical rays of gastral quadriradiates.

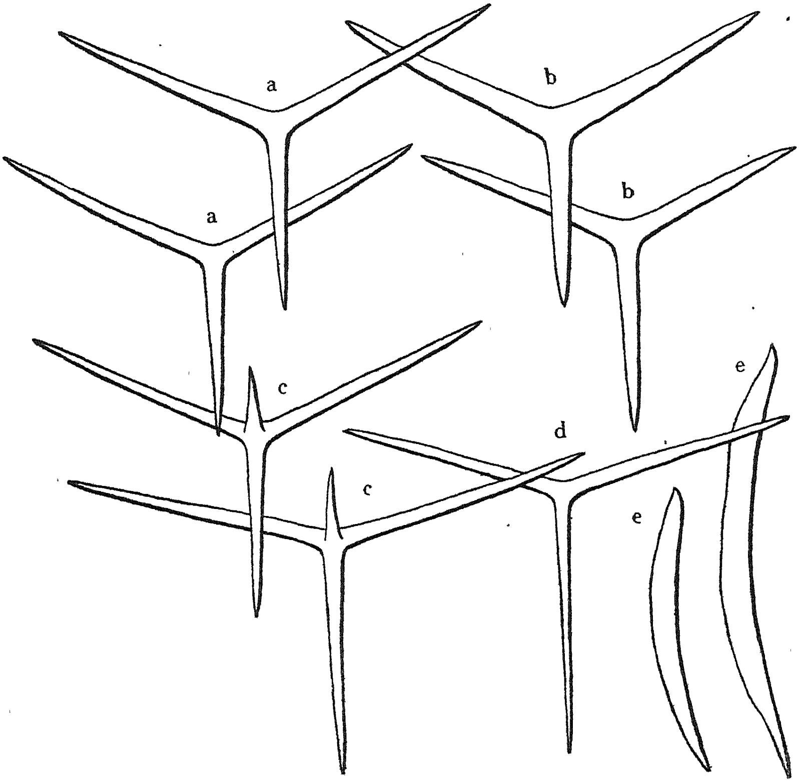
The colour in alcohol is nearly white and the texture is moderately firm and elastic.

Structure: — The canal system is of the leuconoid type. The flagellated chambers are closely distributed in the chamber layer and are generally of an oval shape, measuring about 100 μ in diameter.

The dermal skeleton is composed of triradiates which are tangentially arranged in a few layers and of large oxea which are placed nearly right angles to the dermal surface. The tubar skeleton is made up of rather large triradiates which are irregularly and closely packed in the body wall. To the tubar skeleton it may be added the proximal parts of large oxea. The quadriradiates occur along the larger exhalant canals.

The gastral skeleton is as thick as the dermal, consisting of a few layers of tangentially placed gastral tri- and quadriradiates. The apical rays of the latter kind of spicules are projected into the gastral cavity freely. The skeleton of the oscular margin is made up of tri- and quadriradiates, and of hair-like oxea. The former two kinds of spicules have their basal rays directed regularly downwards and have paired rays widely divergent. The hair-like oxea are disposed longitudinally and run parallel with one another.

Spicules (Text-fig. 6) : — Dermal triradiates (a) subregular or slightly sagittal. Basal ray straight, sharply pointed, slightly shorter than paired rays, 150–200 μ long and 10–15 μ thick at base. Paired rays equal, nearly straight, tapering to sharp end, 170–220 μ long and 10–15 μ thick at base.



Text-fig. 6. *Leucandra compacta* (CARTER). a, dermal triradiates; b, tubar triradiates; c, gastral quadriradiates; d, triradiate of oscular margin; e, oxea. (all ×120)

Tubar triradiates (b) similar to the dermal triradiates in shape but are slightly thicker and larger than the latter. Basal rays straight, sharply pointed, 180–230 μ long and 20–28 μ thick at base. Paired rays straight, slightly longer than basal ray, 200–280 μ long and 20–28 μ thick at base.

Gastral triradiates exactly similar to the gastral quadriradiates, except for the absence of an apical ray.

Gastral quadriradiates (c) sagittal. Basal ray straight, shorter than paired rays, 170–220 μ long and 15–20 μ thick at base. Paired rays equal, widely divergent, 240-290 μ long and 15–20 μ thick at base. Apical ray slightly curved, sharply pointed, shorter and thinner than facial rays, 80–90 μ long and 10–13 μ thick at base.

Triradiates of oscular margin (d) strongly sagittal. Basal ray slender, straight, sharply pointed, slightly shorter and thinner than paired rays, about 200 μ long and 10 μ thick at base. Paired rays nearly equal, widely divergent, 220 μ long and about 12 μ thick at base.

Quadriradiates of oscular margin like the triradiates of the same, only differing in the presence of short apical ray. Apical ray curved upwards, sharply pointed, shorter than facial rays, about 80 μ long and 10 μ thick at base.

Oxea (e) stout, elongate spindle-shaped, sharply pointed at both ends, more or less curved, 380–750 μ long and 30–40 μ thick in the thickest parts.

Remarks: — This species was first described by CARTER in 1886 from New Zealand but neither photographs nor drawings of spicules have been given. The writer, therefore, appended here both the figures of spicules and a photograph of the specimen included in the collection.

Previously known Distribution: — Port Phillip Heads, N. Z. (CARTER).

Locality: — Uschuaria, near the Strait of Magellan.

17) *Leucandra haurakii* BRØNDSTED

(Pl. VII, fig. 14; text-fig. 7)

Leucandra haurakii, BRØNDSTED, 1926, p. 311.

This species is represented by a single specimen (Pl. VII, fig. 14) in the collection. The sponge forms an elongated cylindrical sac, broadest nearer the base by which attached to the substratum, and provided with an osculum at the upper end. It is about 14 mm high and 5 mm in diameter. The osculum is nearly naked and is a slit-like in shape with breadth of 2 mm. The dermal surface is uneven and is hispid owing to the projecting large oxea. The body wall is about 2 mm thick in the middle parts. The gastral cavity is nearly straight, extending to the base. The surface of the gastral cavity is perforated by a number of large exhalant apertures and is slightly hispid under the hand-lens due to the projecting apical rays of gastral quadriradiates.

The colour in alcohol is nearly white with faint yellowish tint and the texture is hard.

Structure: — The canal system is typical. The flagellated chambers are nearly ovoid in form with diameter of 60–80 μ and are densely set together in the chamber layer.

The dermal skeleton is made up of several layers of tangentially placed triradiates. Large oxea project outwards through the dermal cortex and give to outer surface of the sponge a hispid appearance, while more than half of the spicules are embedded in the chamber layer. The tubar skeleton is composed of mainly triradiates which are densely and confusedly packed in the chamber layer and of proximal parts of large oxea. Basal rays of some few subgastral triradiates are added to the skeleton. The walls of the larger exhalant canals are provided with quadriradiates, the apical rays projecting into the canal. The gastral skeleton is thin, containing a few layers of quadriradiates with apical rays projecting as usual into the gastral cavity.

Spicules (Text-fig. 7): — Dermal triradiates (a) subregular or slightly sagittal. Basal ray straight, sharply pointed, 100–145 μ long and 8–10 μ thick at base. Paired rays equal, either straight or slightly curved forwards, 100–140 μ long and 8–10 μ thick at base.

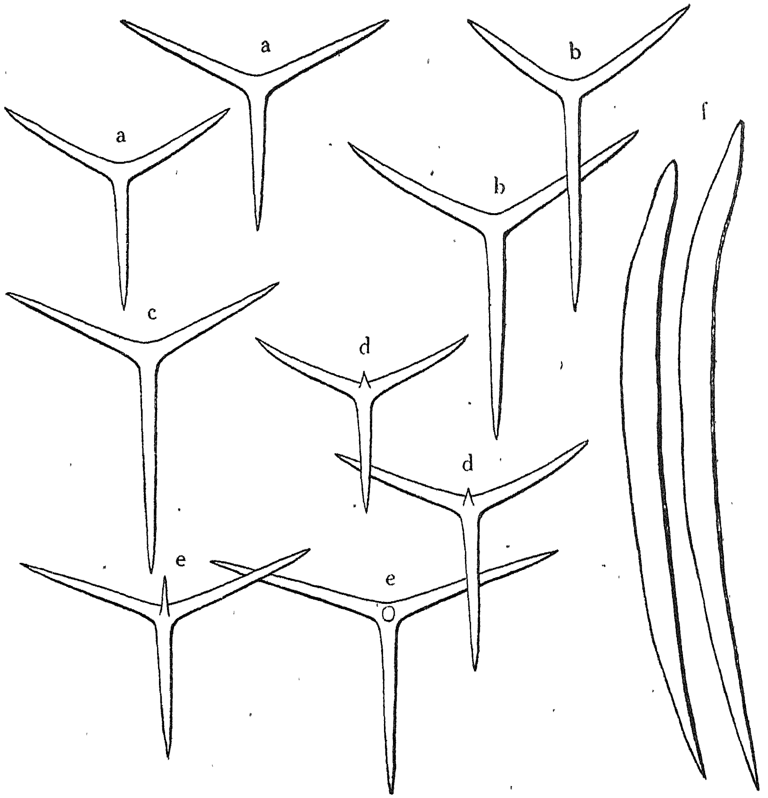
Tubar triradiates (b) strongly sagittal. Basal ray straight, tapering to the sharply pointed end, longer than paired rays, 160–220 μ long and 10–14 μ thick at base. Paired rays nearly equal, usually curved forwards, 110-135 μ long and 10–14 μ thick at base.

Subgastral triradiates (c) similar to the tubar triradiates, only differing in having wider oral angles.

Quadriradiates of larger exhalant canals (d) sagittal. Basal ray straight, longer than paired rays, 160–200 μ long and 12–14 μ thick at base. Paired rays equal, gently curved forwards, 130–150 μ long and 12–14 μ thick at base. Apical ray sharply pointed, shorter and slightly thinner than facial rays, 40–90 μ long and 8-12 μ thick at base.

Gastral quadriradiates (e) also sagittal. Basal ray straight, sharply ended, either equal to or very slightly longer than paired rays, 150–190 μ long and 10–15 μ thick at base. Paired rays equal, nearly straight, 150–185 μ long and 10–15 μ thick at base. Apical ray slightly curved oralwards, fairly sharply pointed, 120–180 μ long and 10–12 μ thick at base.

Oxea (f) elongate spindle-shaped, usually more or less curved, sharply pointed at the proximal end while the distal is somewhat rounded. They



Text-fig. 7. *Leucandra haurakii* BRØNDSTED, a, dermal triradiates; b, tubar triradiates; c, subgastral triradiate; d, quadriradiates of larger exhalant canals; e, gastral quadriradiates; f, oxea. (all ×150)

measure 470–780 μ in length and 27–35 μ in greatest thickness.

Remarks: — This species was first described in 1926 by BRØNDSTED as found in New Zealand. Unfortunately, however, he has not been given any figure, but as the specimen at my hand agrees well with his original description, the writer inclined to identify it with this species.

Previously known Distribution: — Moko Hinau Island, N. Z. (BRØNDSTED).

Locality: — Puerton Pantelon, Feuerland.

18) *Leucandra reniformis*, n. sp.

(Pl. VII, fig. 15; text-fig. 8)

In the collection there exists two specimens of this new species which were obtained from two different localities.

The smaller one which came frow Picton Island is of an irregular oval form measuring 5 × 3.5 mm, attached to a gastropod shell.

The larger specimen (Pl. VII, fig. 15) on which the further description is based, forms an irregular oval shape, more or less dorso-ventrally compressed, and attached to some algae by its base directly. It measures 7 mm in height, 21 mm in length, and 12.5 mm in breadth. There are three naked oscula on the upper side of the body, whose sizes are 1.3 × 0.8 mm, 1 × 0.6 mm, and 1 × 0.5 mm. The dermal surface is slightly hispid on account of projecting oxea. The gastral cavity is very narrow and is branched in a very irregular manner. The gastral surface appears to be smooth to the naked eye.

The colour in alcohol is nearly white and the texture is firm and elastic.

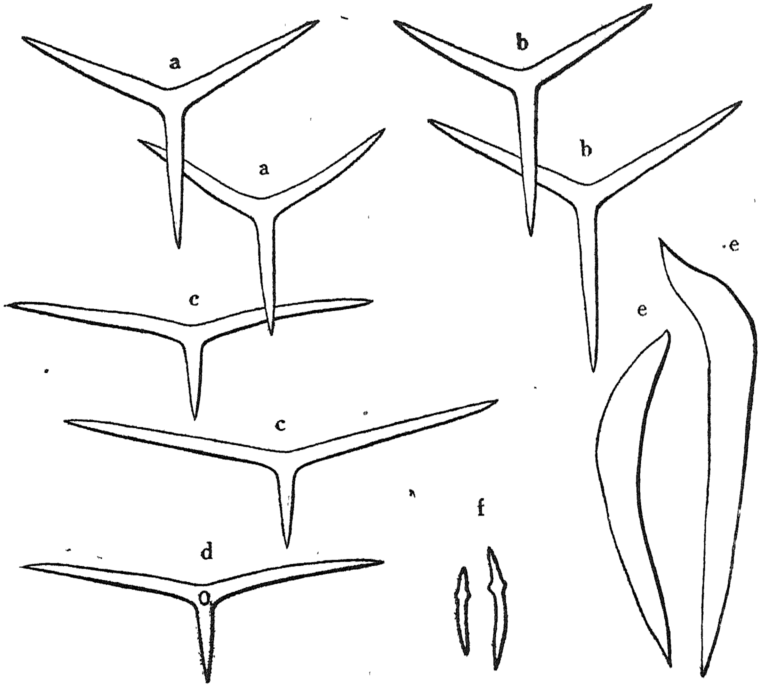
Structure: — The canal system is of the leuconoid type. The flagellated chambers are of spherical or oval shape, measuring 80–100 μ in diameter and are thickly packed in the chamber layer.

The dermal skeleton is hardly distinguishable from the tubar skeleton. It consists of a few layers of tangentially arranged triradiates, of large oxea, and of densely distributed microxea. The greater parts of large oxea are embedded in the chamber layer and project only a little distally. The tubar skeleton is made up of triradiates which are irregularly set together and of the proximal parts of large oxea. The gastral skeleton is as thick as the dermal, but is fairly well distinguishable from the chamber layer, consisting of tri- and quadriradiates. The both kinds of spicules are closely set and are disposed parallel to the gastral surface. The gastral quadriradiates are smaller in number than the triradiates. There is no special skeleton around the osculum.

Spicules (Text-fig. 8): — Dermal triradiates (a) slightly sagittal, with paired rays slightly longer than basal ray. All rays are of equal thickness being 13–18 μ at base. Basal ray straight and sharply pointed with the length of 100–170 μ. Paired rays equal, either nearly straight or slightly curved forwards being 110–180 μ long.

Triradiates of chamber layer (b) exactly similar to the dermal triradiates above mentioned.

Gastral triradiates (c) strongly sagittal. Basal ray straight, much shorter than paired rays, 80–90 μ long and 13–18 μ thick at base. Paired rays equal, nearly straight, tapering to sharp points, 150–170 μ long and 13–18 μ thick at base.



Text-fig. 8. *Leucandra reniformis*, n. sp. a, dermal triradiates: b, tubar triradiates; c, gastral triradiates; d, gastral quadriradiate; e, large oxea; f, dermal microxea. (a–e ×150; f ×240)

Gastral quadriradiates (d) exactly similar to triradiates of the same, except in having short apical ray. Apical ray slightly curved, shorter and thinner than facial rays, 45–55 μ long and 10–15 μ thick at base.

Large oxea (e) stout, slightly curved, sharply pointed at both ends, but thickest nearer the distal end, variable in length, 230–420 μ long and 28–45 μ thick in the thickest parts.

Dermal microxea (f) more or less curved, sharply pointed at both ends. Close to one end occurs a nodiform ring. They measure 60–70 μ in length and about 6 μ in thickness.

Remarks: — This species appears to be closely resembled to BREITFUSS's *Leucandra fernandensis*[1] in spiculation, but may be easily distinguished from the latter by the absence of dermal quadriradiates, by the shape of oxea, and by the external appearance.

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[1] *Leuconia fernandensis* BREITFUSS, 1898, p. 466, Taf. 27, fig. 9.

19) *Leucandra uschuariensis*, n. sp.

(Pl. VII, fig. 16; text-fig. 9)

This new species is based upon five specimens in the collection. They are nearly similar in appearance but are variable in length ranging from 16 mm to 28 mm. The writer has selected as the type of this species the largest specimen (Pl. VII, fig. 16) upon which to base further description.

The sponge forms an elongated solitary person, strongly laterally compressed, the broadest part being nearer the base and tapers towards the upper end. It measures 28 mm in length and is 11 mm broad in the broadest parts. The osculum at the upper end is elliptical in shape with a diameter of 1.5–2 mm long, and it shows no special structure. The dermal surface is slightly hispid owing to the presence of the projecting oxea while the gastral seems nearly smooth. The gastral cavity is comparatively narrow and is branched irregularly. The body wall is 3.6 mm in thickness at the middle of the body.

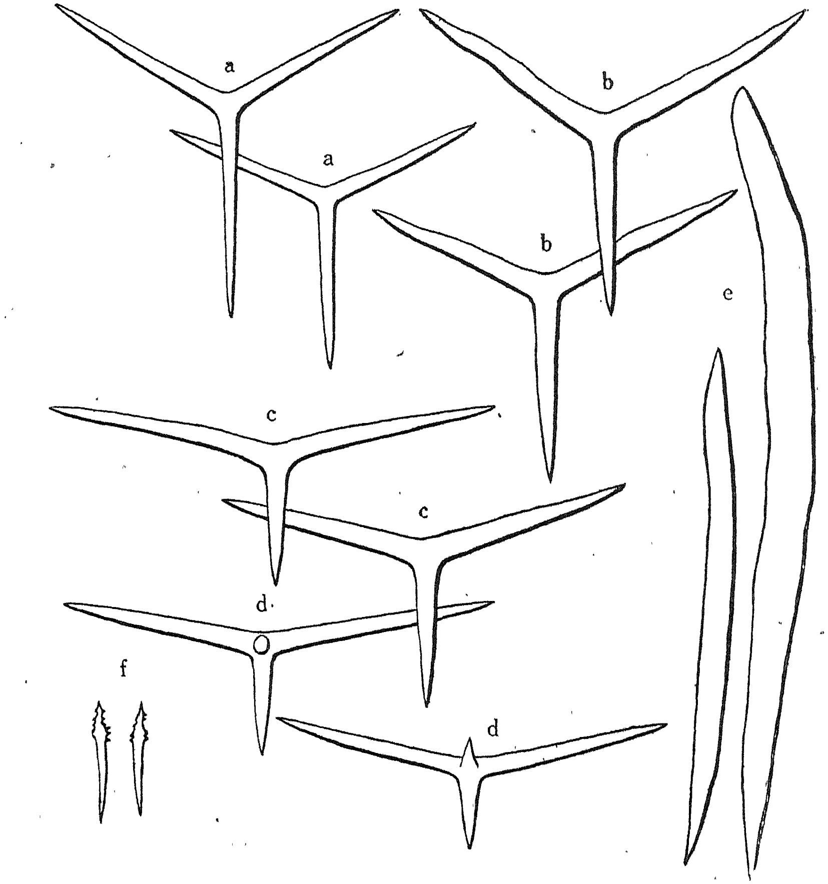
In spirit, the colour is nearly white and the texture is rather hard and very elastic.

Structure: — The canal system is leuconoid. The flagellated chambers are oval in shape with a diameter of about 60 μ. The dermal skeleton is very well distinguishable from that of the chamber layer as there exists numerous subdermal cavities of variable sizes beneath the surface. It is composed of a few layers of tangentially arranged triradiates, of large oxea, and of microxea. The large oxea project from the surface to some extent while the proximal half is embedded in the body wall. Microxea are very densely distributed all over the surface.

The skeleton of chamber layer is made up of triradiates and of proximal parts of large oxea. The tubar triradiates are scattered irregularly in the chamber layer. The gastral skeleton is thicker than the dermal, consisting of several layers of triradiates and quadriradiates. The latter kind of spicules are small in number and their apical rays project into the gastral cavity. The oscular margin is made up of the dermal and gastral spicules only and thus there is no other kinds of spicules to be mentioned.

Spicules (Text-fig. 9): — Dermal triradiates (a) slightly sagittal. Basal ray straight, tapering to sharp end, 150–200 μ long and 10–15 μ thick at base. Paired rays equal, nearly straight, slightly shorter than basal ray, 145–190 μ long and 10–15 μ thick at base.

Tubar triradiates (b) also sagittal. Basal ray straight, sharply pointed,



Text-fig. 9. *Leucandra uschuariensis*, n. sp. a, dermal triradiates; b, tubar triradiates; c, gastral triradiates; d, gastral quadriradiates; e, large oxea; f, microxea. (a–e ×150; f ×240)

either equal to or slightly shorter than paired rays, 120–220 μ long and 18–23 μ thick at base. Paired rays nearly equal, slightly undulated, 145–220 long and 18–23 μ thick at base.

Gastral triradiates (c) strongly sagittal. Basal ray straight, sharply ended, much shorter than paired rays, 90–140 μ long and 14–18 μ thick at base. Paired rays equal, widely divergent, 180–220 μ long and 14–18 μ thick at base.

Gastral quadriradiates (d) nearly similar to gastral triradiates, except for the presence of apical ray. Apical ray slightly curved oralwards, sharply pointed, shorter and thinner than facial rays, 50–65 μ long and

10–14 μ thick at base.

Large oxea (e) elongate spindle-shaped, broadest at a point nearer one end than the other, more or less irregular in outline, 470–700 μ long and 25–45 μ thick at the thickest parts.

Microxea (f) slightly curved, sharply pointed at both ends, provided with a number of spines close to one end, 55–85 μ long and 4–7 μ thick at the thickest portion.

Remarks: — In external appearance, this species appears to be closely allied to *Leucandra gemmipara* THACKER[1], while in spiculation, it resembles *L. dwarkaensis* DENDY[2] and *L. comata* BRØNDSTED[3]. This species, however, differs from THACKER's species in spiculation and from DENDY's species in external appearance and in gastral radiates. From *Leucandra comata*, it may be easily distinguished by the difference of dermal and tubar triradiates.

Locality: — Uschuaria.

LITERATURE CITED

ARNESEN, E. (1901). Spongier fra den norske kyst. I. Calcarea. Systematisk katalog med. bemerkninger og bestemmelsestable. Bergens Mus. Aarbog. No. 5.

BIDDER, G. P. (1898). The Skeleton and Classification of Calcareous Sponges. Proc. Roy. Soc. London, Vol. 64, No. 403, pp. 61–76.

BOWERBANK, J. S. (1845). Description of a new Genus of Calcareous Sponges (*Dunstervilla*). Ann. Mag. Nat. Hist. (ser. 1) Vol. 15, pp. 297–300.

—— (1864–1882). A Monograph of the British Spongiadae. Roy. Soc. London, 4 Vols.

BREITFUSS, L. (1897). Catalog der Calcarea der zoologischen Sammlung des königlichen Museums für Naturkunde zu Berlin. Arch. f. Naturgesch. Jahrgang 63, Bd. 1, pp. 205–226.

—— (1898). Kalkschwammfauna des weisen Meeres und der Eismeerküsten des europäischen Russlands mit Berücksichtigung und Aufstellung der Kalkschwammfauna der arktischen Region. Mémoires de l'Acad. Impér. des Sciences, St. Pétersbourg, (ser. 8) Vol. 6, No. 2.

—— (1898). Die Kalkschwämme der Sammlung Plate (Fauna Chilensis, Bd. 1). Zool. Jahrb. Suppl.-Bd. 4, pp. 455–470.

—— (1935). Le Spugne calcaree dell' Adriatico con riflesso a tutto il Mediterraneo. Comitata, Talassografico Intaliano Mem. 223, pp. 1–43.

BRØNDSTED, H. V. (1926). Sponges from New Zealand. Part II. Paper from Dr. TH. MORTENSEN's Pacific Expedition 1914–16. XXXV. Vidensk. Medd. fra Dansk naturh. Foren, Bd. 81, pp. 295–331.

—— (1928). Die Kalkschwämme der deutschen Südpolar-Expedition 1901–1903. Deutsche Südpolar-Expedition XX. Zool. pp. 1–47.

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[1] *Leucandra gemmipara* THACKCR, 1908, p. 779, Pl. 40, fig. 9, text-fig. 166.

[2] *Leucandra dwarkaensis* DENDY, 1915, p. 88, Pl. 1, fig. 6, Pl. 2, fig. 10.

[3] *Leucandra comata* BRØNDSTED, 1928, p. 43, figs. 33–35.

BURTON, M. (1934). Sponges. Swedish Antarctic Expedition 1901–1903. Vol. III, No. 2. pp. 1–58, Pls. 1–8.

CARTER, H. J. (1885–1886). Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia. Ann. Mag. Nat. Hist. (ser. 5), Vol. 17, pp. 431–441; pp. 502–516; Vol. 18, pp. 34–55; pp. 126–149.

DENDY, A. (1891). A Monograph of the Victorian Sponges. Part I. The Organisation and Classification of the Calcarea Homocoela, with Descriptions of the Victorian Species. Trans. Roy. Soc. Victoria, Vol. 3, No. 1, pp. 1–82.

—— (1892). Synopsis of the Australian Calcarea Heterocoela, with a proposed Classification of the group, and Descriptions of some new Genera and Species. Proc. Roy. Victoria, (n. s.) Vol. 5, pp. 69–116.

—— (1918). Calcareous Sponges. Australasian Antarctic Expedition 1911–14. Scientific Reports, ser. C. Zool. Bot., Vol. 6, Part I.

DENDY, A. and FREDERICK, L. M. (1924). On a Collection of Sponges from the Abrolhos Islands, Western Australia. Journ. Linn. Soc. London, Zool., Vol. 35, pp. 477–518.

DENDY, A. and ROW, R. W. H. (1913). The Classification and Phylogeny of the Calcareous Sponges, with a Reference List of all the described Species, systematically arranged. Proc. Zool. Soc. London, pp. 704–813.

ELLIS, J. and SOLANDER, D. (1786). Natural History of many curious and uncommon Zoophytes collected from various parts of the Globe. London.

GRAY, J. E. (1867). Notes on the Arrangement of Sponges with Descriptions of some new Genera. Proc. Zool. Soc. London, pp. 492–558.

HAECKEL, E. (1870). Prodromus eines Systems der Kalkschwämme. Jenai. Zeitschr., Vol. 5, pp. 236–254.

—— (1872). Die Kalkschwämme, eine Monographie. Berlin.

HÔZAWA, S. (1940). On Some Calcareous Sponges from Japan. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 15, No. 1, pp. 29–58, Pls. 4, 5.

—— (1940). Report on the Calcareous sponges obtained by the Zoological Institute and Museum of Hamburg. Part I. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 15, No. 2, pp. 131–163, Pls. 6, 7.

KIRK, H. B. (1893). Contribution to a Knowledge of the New Zealand Sponges. Trans. New Zealand Inst., Vol. 26, pp. 175–179.

—— (1897). Notes on New Zealand Sponges. Fourth Paper. Trans. New Zealand Inst., Vol. 30, pp. 313–316.

LAUBENFELS, M. W. (1932). The Marine and Fresh-water Sponges of California. Proc. U. S. Nat. Mus., Vol. 81, pp. 1–140.

LENDENFELD, R. von (1885). A Monograph of the Australian Sponges. Part III. The Calcispongiae. Proc. Linn. Soc. New South Wales, Vol. 9, pp. 1083–1150.

LUNDBECK, W. (1909). The Porifera of East Greenland. Meddel. om Grönland, Vol. 29, pp. 423–464.

MINCHIN, E. A. (1905). The Characters and Synonymy of the British Species of Sponges of the Genus *Leucosolenia*. Proc. Zool. Soc. London, Vol. 2, pp. 349–396.

POLÉJAEFF, N. (1888). The Calcarea. Report on the Scientific Results of the Voyage of H. M. S. „Challenger". Zoology. Vol. 8.

RIDLEY, S. O. (1881). Spongida collected during the Expedition of H. M. S. Alert in the Straits of Magellan and on the Coasts of Patagonia. Proc. Zool. Soc. London, pp. 107–137.

—— (1884). „Spongida". Reports on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H. M. S. Alert, 1881-1882. pp, 366-482; 582-630, London.

Row, R. W. H. (1909). Reports on the Marine Biology of the Sudanese Red Sea. XIX. Report on the Sponges collected by Mr. Cyril Crossland in 1904-1905. Part I. Calcarea. Journ. Linn. Soc. London, Zoology, Vol. 31, pp. 182-214.

Row, R. W. H. and Hôzawa, S. (1931). Report on the Calcarea obtained by the Hamburg South-West Australian Expedition of 1905. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 6, pp. 727-809, Pls. 19-21.

Tanita, S. (1941). Report of the Biological Survey of Mutsu Bay. 35. Studies on the Calcarea of Mutsu Bay. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 16, pp. 1-8, Pl. 1.

—— (1941). Calcareous Sponges obtained from Onagawa Bay and its Vicinity. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 16, pp. 263-282, Pl. 17.

—— (1942). Key to all the described Species of the Genus *Leucosolenia* and their Distribution. Sci. Rep. Tohoku Imp. Univ. Biol., Vol. 17, pp. 71-92.

Topsent, E. (1907). Eponges calcaries recueillis par le Francais dans l'Antarctique (Expédition du Dr. Charcat). Bullet. Mus. Hist. Nat. Paris, pp. 539-544.

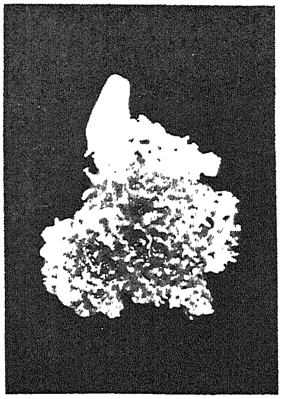
EXPLANATION OF THE PLATES (All ×2)

PLATE VI.

Fig. 1. *Leucosolenia falklandica* Breitfuss.
Fig. 2. *Leucosolenia feuerlandica*, n. sp.
Fig. 3. *Leucosolenia lucasi* Dendy.
Fig. 4. *Leucetta microraphis* Haeckel.
Fig. 5. *Sycon coronatum* (Ellis and Solander).
Fig. 6. *Sycon elegans* (Bowerbank).
Fig. 7. *Sycon ornatum* Kirk.
Fig. 8. *Vosmaeropsis inflata*, n. sp.
Fig. 9. *Vosmaeropsis ovata*, n. sp.

PLATE VII.

Fig. 10. *Grantia genuina* Row and Hôzawa.
Fig. 11. *Leucandra astricta*, n. sp.
Fig. 12. *Leucandra australiensis* (Carter).
Fig. 13. *Leucandra compacta* (Carter).
Fig. 14. *Leucandra haurakii* Brøndsted.
Fig. 15. *Leucandra reniformis*, n. sp.
Fig. 16. *Leucandra uschuariensis*, n. sp.



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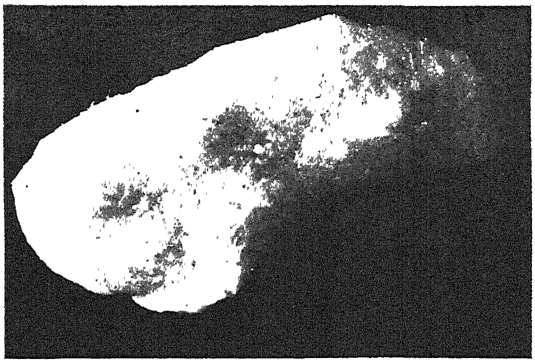

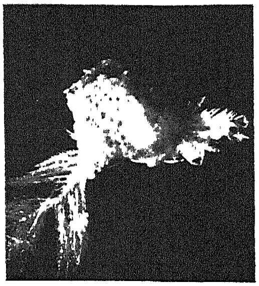

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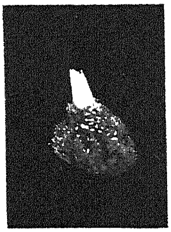

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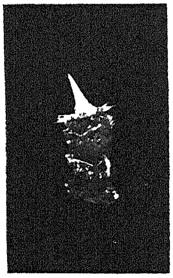

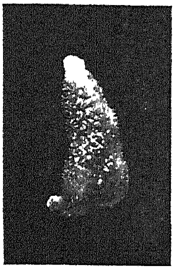

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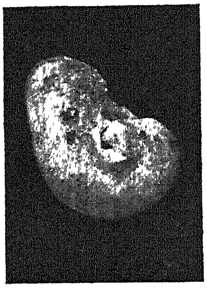

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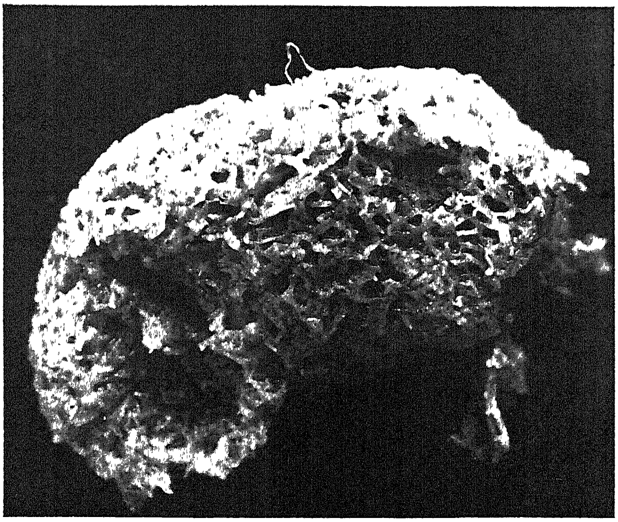
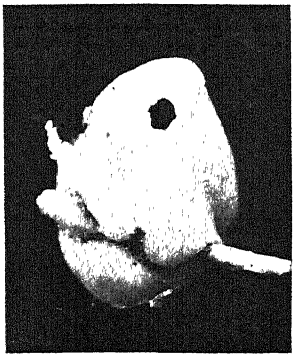
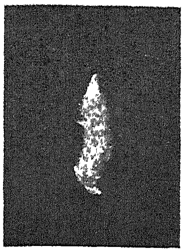




S. TANITA photo.

S. TANITA: Calcarea obtained by the Hamburg Museum.



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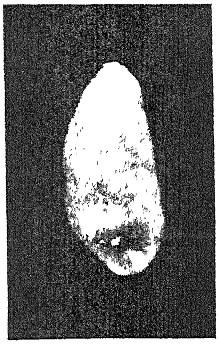

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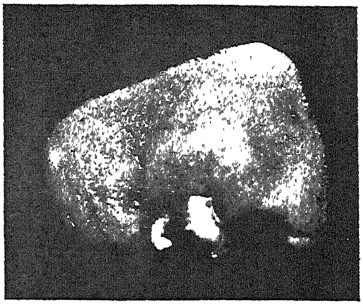

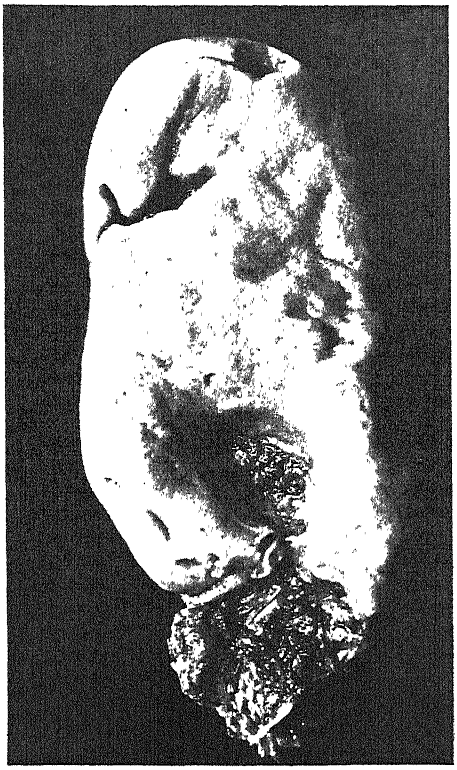

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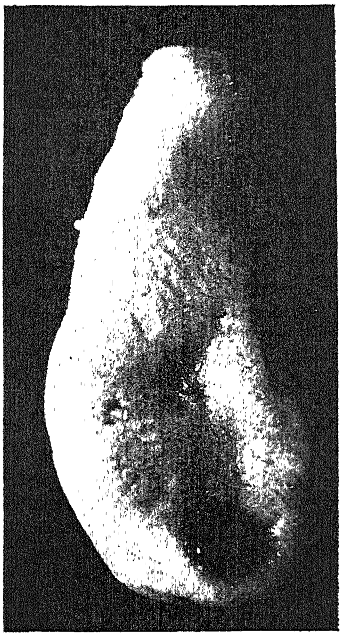

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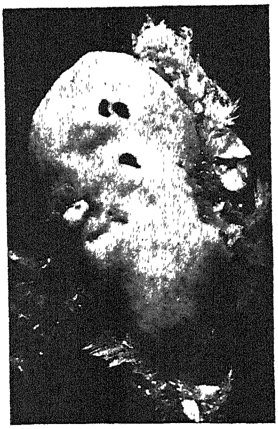

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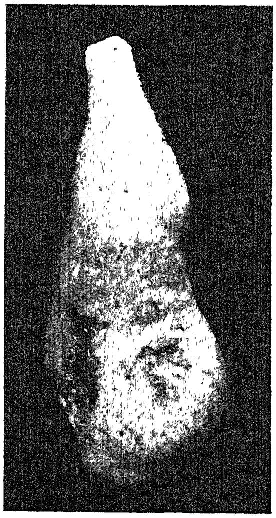

S. Tanita photo.

S. Tanita: Calcarea obtained by the Hamburg Museum.

STUDIES ON THE GROWTH HORMONES OF PLANTS

V. POLAR ROOTLET FORMATION ON ROOT SEGMENTS CULTURED UNDER STERILE CONDITIONS.[1]

BY

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(With 16 Text-figures)

(Received May 29, 1942)

INTRODUCTION

Since the promoting effect of auxins on root formation was discovered, numerous papers on this subject, particularly dealing with the root formation on stems and other above-ground organs have been published. It has been found in these investigations that the polar formation of roots on stem cuttings is caused by the polar transport of auxin. However, works concerning the rootlet formation on roots are not so many in number. ZIMMERMAN & HITCHCOCK ('35) reported the effect of auxins on the production of laterals from aerial roots of *Cissus*. CHOLODNY ('31), FABER ('36), THIMANN ('36), JOST & REISS ('37), THIMANN & LANE ('38), LEVAN ('39) and KOJIMA ('40) have shown the rootlet-inducing effect of auxins on roots of seedlings. Thus it is clear that the rootlet formation on roots is also promoted by auxins. Furthermore, it has been shown that auxins promote the regeneration of roots on root-cuttings of *Taraxacum officinale* (CZAJA '35 a), *Crambe maritima* (STOUGHTON & PLANT '38, PLANT '40), *Cochlearia armoracia* (LINDNER '39, '40) and *Oenothera macrosiphon* (WENT '39), and that the polar rootlet formation on these root-cuttings also seems to be caused by the polar transport of auxins.

From these facts, it is very probable that the native auxin is one of the factors necessary for the formation of laterals on the root of seedlings. In the present work, the rootlet formation on root segments, cut from seedlings and cultured under sterile conditions, has been investigated, and whether auxin shall be regarded as one of the factors controlling the polar rootlet formation on the root segments has been discussed.

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[1] The writer wishes to express his appreciation for the financial aid given by the Japan Society for the Promotion of Scientific Research.

MATERIALS AND METHODS

Pisum sativum was the plant mainly used for the experiments. In some, however, *Helianthus annuus* is also used. Seedlings of these plants were cultured as follows: Seeds were soaked in tap water under diminished pressure for 10–20 minutes, then sterilized in 0.2% (in some experiments, 0.4%) $HgCl_2$ under diminished pressure for 10–20 minutes and finally washed three times in sterile water. These seeds were allowed to germinate on sterile 1% agar and kept at about 20°–25°C. After 4 days, the roots of the pea seedlings became about 5 cm in length. Various parts of the roots of these seedlings were cut off and cultured on nutrient agar under sterile conditions.

The culture medium was prepared after BONNER & ADDICOTT ('37). It contained the following salts and sugar in 1 litre of distilled water: $Ca(NO_3)_2 \cdot 4H_2O$ 236 mg, $MgSO_4 \cdot 7H_2O$ 36 mg, KNO_3 81 mg, KCl 65 mg, KH_2PO_4 12 mg, $Fe_2(SO_4)_3$ 2 mg and sucrose 40 g. To this 10 g of agar was added. Other substances such as extract of yeast or vitamin B_1 were not added. In most cases, the segments were cultured in test-tubes containing about 10 cc of the medium. The cultures were kept at 20°–25°C in a dark or dim place.

The number of rootlets developed was counted daily during the cultivation. Finally, the number of rootlet primordia on the segments, which had been clarified in a concentrated solution of chloral hydrate, was counted through a magnifying glass (8×). In the pea root, at the beginning of the experiments, no rootlet primordia were found by means of this method on the apical 2 cm part; a few were visible, in rare cases, on the 2–3 cm zone from the tip.

EXPERIMENTS

1. Culture of Decapitated Roots

From pea seedlings, the entire roots 4.5–5.5 cm long were isolated. After the tips 2 mm in length were removed, each root was placed on nutrient agar slant in a large test-tube. During the culture, the roots were kept horizontal by inclining the test-tubes. At the beginning of the culture, a few rootlets had already grown out or were about to appear on the basal portion of the roots.

The number of rootlets grown out on the root segment was counted daily. Results are shown in Fig. 1. The rootlets develop only on the

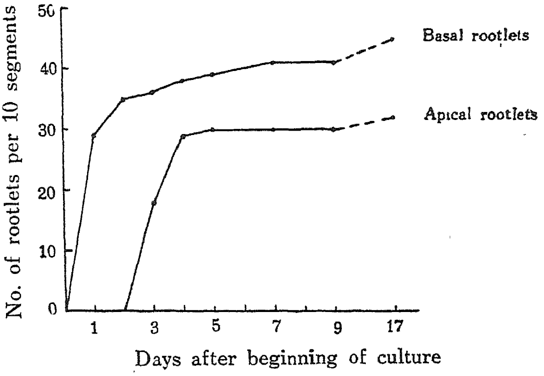

Fig. 1. Number of rootlets developed on root segments. Mean of 14 segments.

basal and apical, but never on the middle portion of the cultured segment. The basal rootlets are distributed within 16 mm from the base, while most of the apical ones are formed near the apical cut surface. On the basal portion, most of the rootlets grow out in one day from the beginning of the experiment. In a further two days, rootlets begin to appear on the apical portion. The rooting almost ends in four days. It is quite reasonable to think that most of the basal rootlets developed from pre-existing primordia, and that the apical ones were formed anew during the culture.

TABLE 1.

Length of Rootlets after 17 Days. Mean of 14 Segments.

	Length per segment (mm)	Length per rootlet (mm)	Mean of the longest rootlets (mm)
Basal rootlets	63	13	21
Apical rootlets	118	37	48

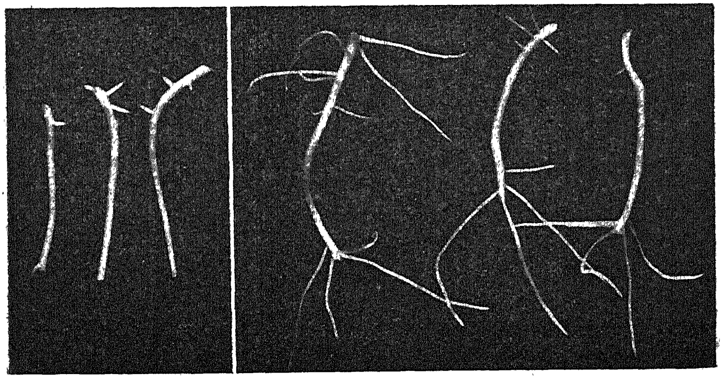

Fig. 2. Rootlet development on isolated roots (tips 1 cm removed). Left, 3 roots placed on plain agar; right, 3 roots placed on nutrient agar. Photographed a week after isolation.

The length of the rootlets after 17 days is shown in Tab. 1. The apical rootlets grow longer than the basal ones, which cease to elongate earlier than the former.

A similar experiment was carried out with roots, from which the tips 1 cm long had been removed. The isolated root-segments were cultured in Petri dishes containing nutrient agar or plain agar. Six roots were placed in each dish. Results are similar to those of the former experiment. (See Fig. 2.)

2. Culture of Various Parts of a Root

α) The following experiment was made to compare the formation and the development of rootlets[1] on root segments taken from various parts of the root. Pea roots grown about 5 cm long were used. After the tips 2 mm long were removed, the roots were cut into 5 pieces of 1 cm long. (Length of the most basal pieces was 0.5–1 cm.) The segments were numbered I to V, from apex to base. Each segment was placed horizontally on nutrient agar slant in a test-tube. In segments V, a small number of rootlets had been visible or were about to grow out at the beginning of the experiment.

The number of rootlets found on various parts of each segment after 17 days is shown in Fig. 3. In segment I, most of the rootlets are formed near the apical end of the segment and few are found on other parts. The polarity of the rootlet distribution is less distinct in the segments taken from the more basal portions of the root, owing to the counterbalance of the increased number of basal rootlets with the decreased number of apical ones. In the most basal segment V, the polarity is reverse. (However, as men-

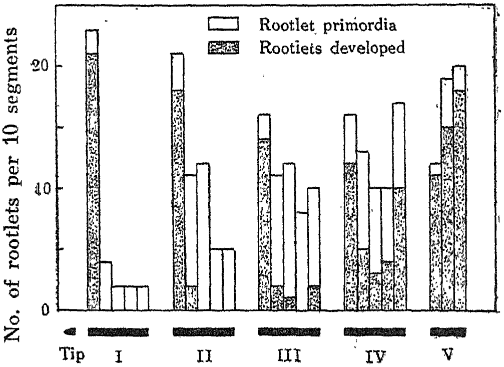

Fig. 3. Distribution of rootlets on segments taken from various parts of root. Results after 17 days. Mean of 13 segments.

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[1] In this paper, the formation of rootlets was distinguished from the outgrowth of rootlets from the primordia. The "number of rootlets formed" indicates the sum of the "numbers of rootlets developed" and "rootlet primordia".

tioned above, the basal segments had already shown some rootlets at the time of isolation.) Although the fact that the rootlets are more ready to be formed on basal parts of the segment than on other parts except the apex is not so clear in this experiment, it will be seen quite clearly in the later ones.

If we consider only the developed rootlets, the polarity is more strict. The apical end of the segments shows an especially high rate of development into rootlets from the primordia, though in the basal segments, the basal end also gives a fairly high rate of development.

Tab. 2 shows that the total number of rootlets on each segment is greater in the more basal segments. The number of developed rootlets, however, is greater in segments V and IV than in the other three segments, among which segment I seems to have the greatest number. (See also series B in Tabs. 4 and 5.)

TABLE 2.

Number and Length of Rootlets on Segments after 17 Days. Mean of 13 Segments.

Segment	No. of rootlets formed per 10 segments	No. of rootlets developed per 10 segments	Length per segment (mm)	Length per rootlet (mm)
I	33	21	42	20
II	54	19	33	18
III	57	18	31	17
IV	65	34	53	16
V	51	43	98	23

The number of developed rootlets counted daily during the culture is shown in Fig. 4. In segments V and IV, the rootlets begin to grow out in one day from the beginning of the experiment. In segments I, II and III, however, rooting begins in a further two days. Most of the rootlets on segment I appear on the first day and practically no subse-

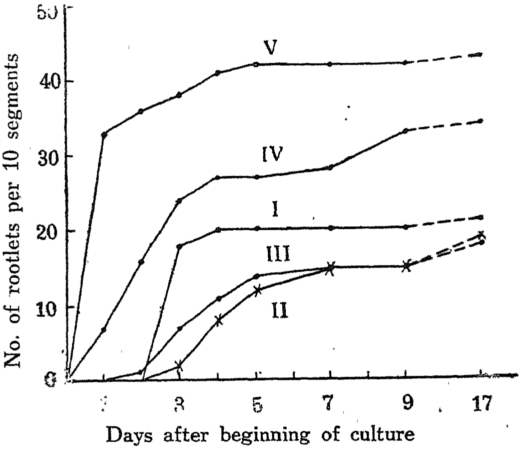

Fig. 4. Number of rootlets developed on various segments. Mean of 13 segments.

quent rooting occurs; while in segments II and III, the rootlets do not appear all at the one time, as in segment I. It seems quite probable that most of the rootlets on segments V and IV developed from pre-existing primordia, and that those on segments I, II and III were formed anew during the culture.

The length of the rootlets after 17 days is shown in Tabs. 2 and 3. In the previous experiment, in which the entire decapitated roots were cultured, it was found that the apical rootlets grew longer than the basal ones. However, Tab. 2 shows that, if the root is cut into pieces and cultured separately, the rootlets, which develop on the basal segment V, are not smaller in length per segment and per rootlet than those grown on the apical segments. Comparing the three apical segments, the rootlets on segment I seem to be the greatest in length. (See also series B in Tabs. 4 and 5.)

Tab. 3 shows that, when the rootlets develop over the whole length of the cultured segments as in IV and V, the same thing is found to be true as was found in the previous experiment: the apical rootlets grow longer than the basal ones. (Refer also to the experiment in sunflowers described later.)

TABLE 3.

Comparison of Length of Rootlets Grown out on Different Portions of Segments after 17 Days. Mean of 13 Segments.

		Length per segment (mm)	Length per rootlet (mm)	Mean of the longest rootlets (mm)
Segment V	Basal rootlets	31	17	21
	Middle rootlets	33	22	26
	Apical rootlets	35	32	37
Segment IV	Basal rootlets	15	10	15
	Middle rootlets	7	17	24
	Apical rootlets	31	20	30

β) In the present experiment, the rootlet formation on root segments, which were either cut into pieces or left intact, was investigated. From 24 pea roots grown 5–6 cm long, apical parts 3 cm in length were cut off. (The tips 2 mm were previously removed.) Half of these segments were left intact (series A), and the rest were cut into three equal pieces which were numbered I to III, from apex to base (series B). They were then kept on nutrient agar slant in test-tubes, with their apical ends downwards. In series A, one segment was placed in each tube, while in series B, three pieces cut from one segment were cultured together.

The number of developed rootlets counted daily is shown in Fig. 5. Result in series B agrees well with that of the former experiment. In each segment of series A, as in segment I of series B, most of the rootlets develop at the one time.

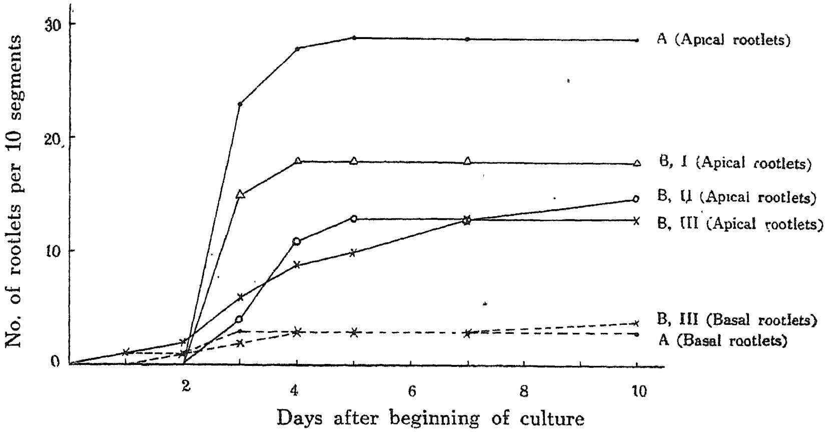

Fig. 5. Number of rootlets developed on various segments. A, series A; B, series B. Mean of 12 segments.

Results after 10 days are shown in Fig. 6 and Tab. 4. Fig. 6 shows that, in both series A and B, especially great numbers of rootlets are formed near the apical cut surface of each segment, and that the number of rootlets formed on other parts, except the apex of the segment, increases towards the base. Thus it is found, that the rootlet formation on the root segment most readily occurs near the apical end and on the basal part of the segment. As it is a well known fact that

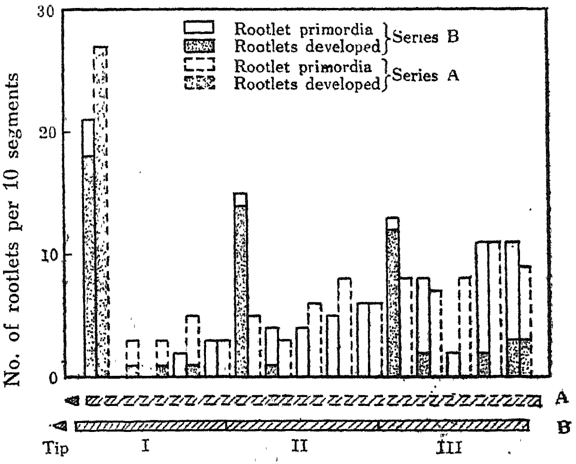

Fig. 6. Distribution of rootlets on various segments. Results after 10 days. Mean of 12 segments.

the lateral root formation of an intact seedling, is started on the basal portion of the root and proceeds acropetally, the formation of more rootlets on the basal part of the segment seems to correspond to the polarity existing in the root material. This view is supported by the fact that, if the rootlets near the apical cut surfaces are excluded, the distribution of rootlets on each segment of series B is much the same as that on the

TABLE 4.

Number and Length of Rootlets after 10 Days.
Mean of 12 Segments.

		No. of rootlets formed per 10 segments	No. of rootlets developed per 10 segments	Length per segment (mm)	Length per rootlet (mm)
Series A	Apical part	39	29	80	27
	Middle "	28	0	0	0
	Basal "	42	3	1	4
	Total	108	32	81	—
Series B	Segment I	26	18	34	20
	" II	34	15	24	16
	" III Apical rootlets	43	18	18	13
	" III Basal "			1	2
	Total	103	50	77	—

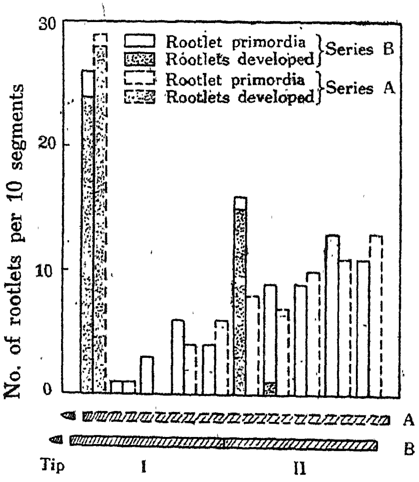

Fig. 7. Distribution of rootlets on various segments. Results after 16 days. Mean of 16 segments.

corresponding part of the segment of series A. Formation of a great number of rootlets near the apical end of the segment shows the causing of a new polarity in the segment, as a result of isolating it from the seedlings.

The distribution of developed rootlets is strictly polar in all cases in this experiment, too.

Tab. 4 shows that the number of rootlets developed on each intact segment of series A is greater than the number of those on each segment of series B, but it is smaller than the total number of rootlets grown out on the three segments taken

TABLE 5.

Number and Length of Rootlets after 16 Days. Mean of 16 Segments.

		No. of rootlets formed per 10 segments	No. of rootlets developed per 10 segments	Length per segment (mm)	Length per rootlet (mm)
Series A	Apical half	41	28	61	22
	Basal ,,	49	0	0	0
	Total	90	28	61	—
Series B	Segment I	41	24	42	17
	,, II	59	16	23	15
	Total	99	40	65	—

together of series B. On the other hand, if the total rootlets formed are compared, they are almost equal in number in both series. The table shows also that the total length of the rootlets is nearly equal in the two series. These facts may indicate that the segments of the two series possess a factor or factors necessary for rootlet initiation and outgrowth in almost equal amount.

Another experiment, in which segments 2 cm long were taken from roots grown 3.5–5cm in length, shows similar results. They are shown in Fig. 7 and Tab. 5.

3. Experiments in *Helianthus annuus*

From roots 6–9 cm long, tips 2 mm were removed. Then three segments of 1 cm long (numbered I, II and III, from apex to base) were

TABLE 6.

Number of Rootlets Developed per 10 Segments (1 cm Long) of Helianthus Roots. Mean of 10 Segments.

Segment	I				II				III			
	Apical rootlets	Middle rootlets	Basal rootlets	Total	Apical rootlets	Middle rootlets	Basal rootlets	Total	Apical rootlets	Middle rootlets	Basal rootlets	Total
After 3 days	74	23	8	105	32	21	4	57	19	18	5	42
,, 4 ,,	79	26	8	113	39	22	5	66	27	22	5	54
,, 7 ,,	84	27	8	119	47	22	5	74	34	22	6	62

TABLE 7.

Number of Rootlets Developed per 10 Segments (3 cm Long) of Helianthus Roots. Mean of 17 Segments.

	Apical rootlets	Middle rootlets	Basal rootlets	Total
After 3 days	138	76	45	258
„ 5 „	—	—	—	306
„ 11 „	158	91	59	308

TABLE 8.

Length of Rootlets after 11 Days. (Helianthus) Mean of 17 Segments.

	Length per segment (mm)	Length per rootlet (mm)	Mean of the longest rootlets (mm)
Basal roots	53	9	15
Middle „	104	11	23
Apical „	407	26	62

cut off and cultured as usual. (The segments were kept horizontal on agar slant.) Results are shown in Tab. 6.

In another experiment, segments 3 cm long taken from roots 4–6 cm in length were cultured in the usual way. (Each segment was placed on agar slant with its apical end downwards.) Results are shown in Tabs. 7 and 8.

Tabs. 6 and 7 show that, in *Helianthus*, unlike in *Pisum*, rootlets develop on the whole length of the segments. Nevertheless, in this case too, the number of apical rootlets is far greater than that of basal ones, and the more apical the segments the more the rootlets.

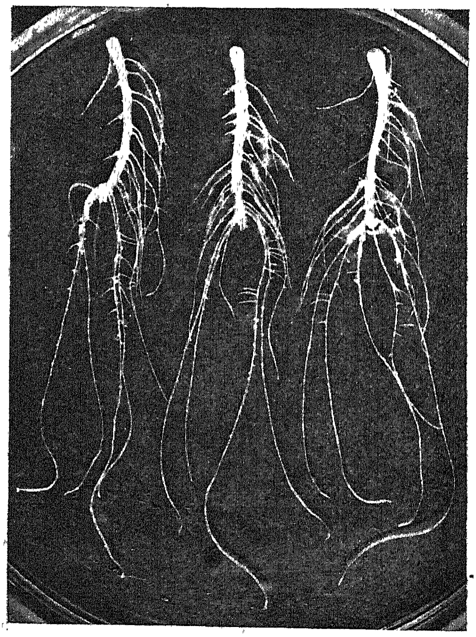

Fig. 8. Rootlet development on root segments of *Helianthus*. Photographed 11 days after isolation.

Rooting seems to progress acropetally, but because of the earlier cessation in elongation of the basal rootlets, the apical ones grow longer as in the case of *Pisum* (Tab. 8 and Fig. 8).

4. Effect of Hetero-Auxin[1]

α) From pea roots 5–6 cm long, tips 2 mm were removed and the next parts 1 cm in length were cut off. These sections were placed horizontally on sterile 1% agar containing 10^{-2}%–10^{-5}% hetero-auxin in Petri dishes. As a control, plain 1% agar was used. The dishes were kept at about 25°C in a dark place. After one day, the root segments treated were well washed with sterile distilled water and cultured as usual. (In this experiment, the plane of agar in test-tubes was not slant.) Results, 16 days after the beginning of culture, are shown in Tab. 9 and Figs. 9 and 10.

TABLE 9.

Number and Length of Rootlets on Segments Treated with Hetero-auxin. Results 16 Days after Beginning of Culture. Mean of 16 Segments.

Concentration of hetero-auxin (%)	No. of rootlets formed per 10 segments	No. of rootlets developed per 10 segments	Length per segment (mm)	Length per rootlet (mm)
10^{-2}	100	59	68	12
10^{-3}	49	29	55	19
10^{-4}	31	19	13	7
10^{-5}	21	13	13	10
0	—	10	7	7

The number of rootlets increases with the concentration of hetero-auxin. (Tab. 9) Also in this experiment, the formation of rootlets is polar, and the outgrowth of

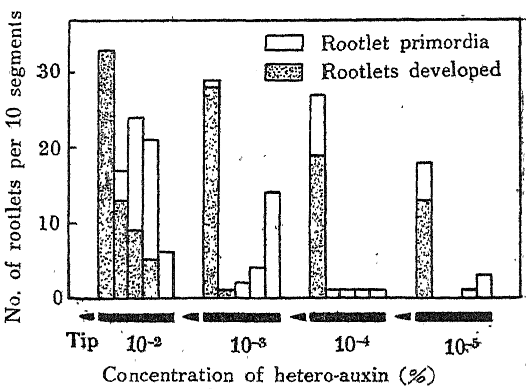

Fig. 9. Distribution of rootlets on root segments treated with hetero-auxin. Results 16 days after beginning of culture. Mean of 16 segments.

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[1] Hetero-auxin was obtained through the kindness of Prof. Dr. S. FUJISE to whom the writer wishes to express many thanks.

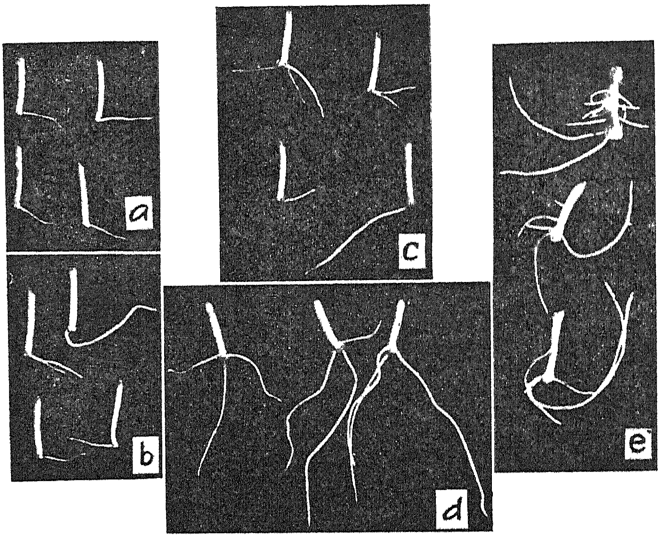

Fig. 10. Rootlet development on root segments treated with hetero-auxin. Concentrations of hetero-auxin: a) 0, b) 10^{-5}%, c) 10^{-4}%, d) 10^{-3}%, e) 10^{-2}%. Photographed 16 days after beginning of culture.

rootlets occurs only on the apical portion of the segments, except in the case of those treated with 10^{-2}% hetero-auxin (Figs. 9 and 10). Fig. 10 shows that the treatment with 10^{-2}% hetero-auxin causes thickening of the segments.

The total length of the rootlets per segment also increases with the concentration of hetero-auxin. Length per rootlet, however, is greatest in the case of those segments treated with 10^{-3}% hetero-auxin, whereas in other cases, it is either a little longer in the treated segments than in the control or else nearly equal to it. (Tab. 9 and Fig. 10).

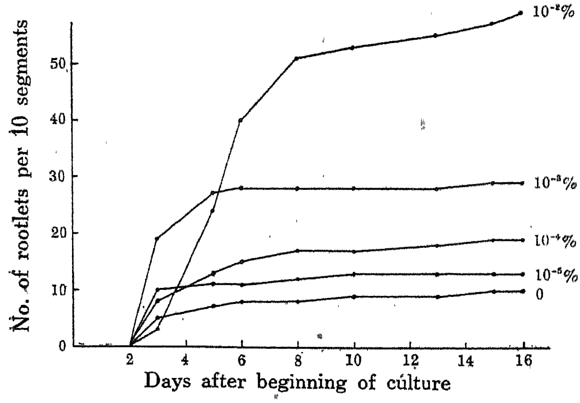

Fig. 11. Number of rootlets developed on root segments treated with 10^{-2}%, 10^{-3}%, 10^{-4}%, 10^{-5}% and 0% hetero-auxin. Mean of 16 segments.

The number of rootlets counted daily is

shown in Fig. 11. It shows that rooting is promoted by treatment with hetero-auxin, but is inhibited at first, when a high concentration is used.

β) From pea roots 4–6 cm long, tips 5 mm were removed and the next parts 1.5 cm long were cut off. These segments were placed vertically, some with their apical and others their basal ends, to about 3 mm in length, in sterile 1% agar containing 10^{-2}%–10^{-4}% hetero-auxin, in Petri dishes. Plain 1% agar was used as a control. The dishes were kept at about 24.5°C in the darkness. After one day, the segments treated were washed five times in sterile distilled water and then cultured in the usual way. Results 6 days after the beginning of culture are shown in Tab. 10 and Figs. 12 and 13.

Also in this experiment, the number of rootlets increases with the concentration of hetero-auxin. The effect of hetero-auxin is greater on the apical portion than on the basal part, not only when the apical end is treated but also when the basal end is treated[1] (Tab. 10 and Fig. 12).

Furthermore, roots grow out always only on the apical end of the segment, except in the case where hetero-auxin in high concentration is used. Rooting on the basal or middle portion of the segment occurs when

TABLE 10.

Number of Rootlets (Ratio to Control) Formed on Segments Treated with Hetero-auxin (in Higher Concentrations) Apically or Basally. Results 6 Days after Beginning of Culture. Mean of 9–11 Segments.

Concentration of hetero-auxin (%)		10^{-2}	10^{-3}	10^{-4}	0
Apical treatment	Basal 2/5-part	1.2	1.7	1.2	1
	Middle 2/5-part	5.3	1.5	1.0	1
	Apical 1/5-part	3.0	2.0	1.8	1
	Total	3.0	1.8	1.4	1
Basal treatment	Basal 2/5-part	2.2	1.9	1.2	1
	Middle 2/5-part	3.1	1.4	1.7	1
	Apical 1/5-part	3.3	2.5	2.0	1
	Total	2.7	2.0	1.5	1

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[1] In the control segment placed with its basal end in agar, as compared with that placed with its apical end in agar, the total number of rootlets formed near the apical end seems to be smaller and the primordia developed into rootlets also fewer in number or developed more slowly (Fig. 16, B). Experiments, to make clear the cause of these facts, are not described in the present work.

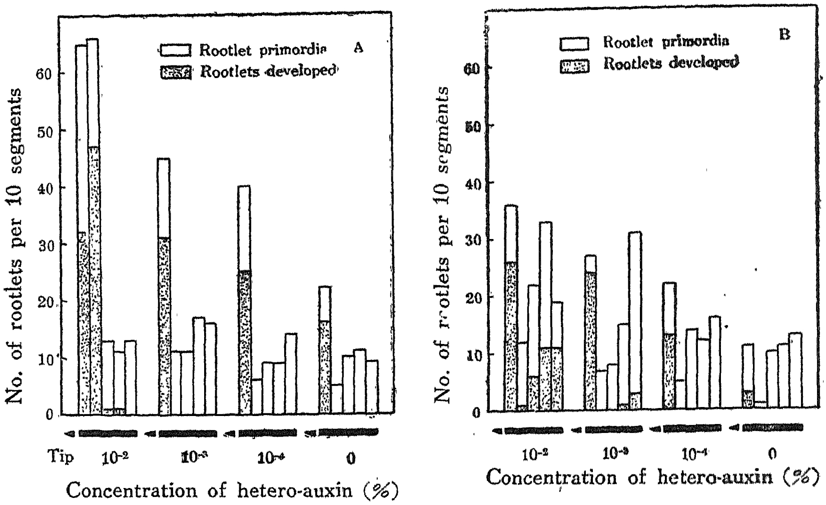

Fig. 12. Distribution of rootlets on root segments treated with hetero-auxin. A, apical treatment; B, basal treatment. Results 6 days after beginning of culture. Mean of 9–11 segments.

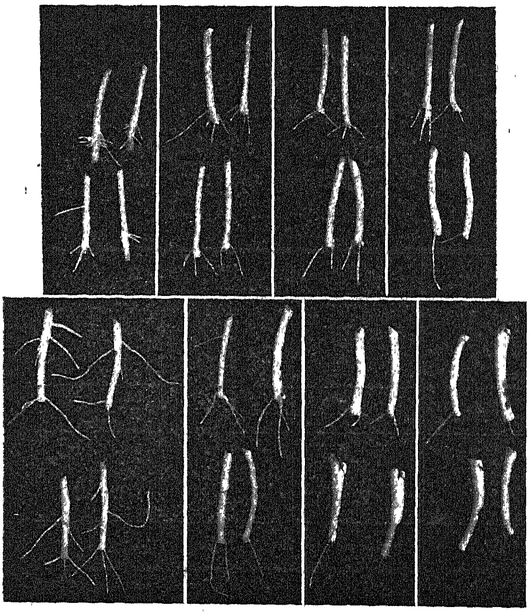

Fig. 13. Rootlet development on root segments treated with hetero-auxin. Above, apical treatment; below, basal treatment. From left to right; $10^{-2}\%$, $10^{-3}\%$, $10^{-4}\%$, 0. Photographed 6 days after beginning of culture.

hetero-auxin in high concentration is applied to the base, or it exceptionally occurs by applicating to the apex (Figs. 12 and 13).

The number of developed rootlets counted daily is shown in Fig. 14. Fig. 14, A is similar to Fig. 11. Fig. 14, B shows no inhibiting effect of hetero-auxin in high concentration on rooting.

The same experiment as the above mentioned was made by using hetero-auxin of lower concentrations ($10^{-5}\%$ and $10^{-6}\%$). In this experiment, the ends of the segments about 4 mm in length were treated.

Tab. 11 and Fig. 15 show that while hetero-auxin

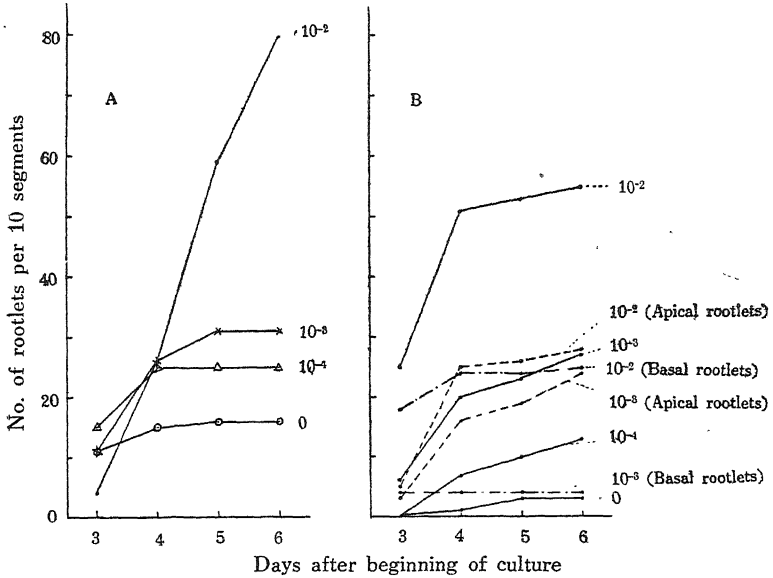

Fig. 14. Number of rootlets developed on root segments treated with $10^{-2}\%$, $10^{-3}\%$, $10^{-4}\%$ and 0% hetero-auxin. A, apical treatment; B, basal treatment. Mean of 9–11 segments.

seems to be effective when applied to the base, the effect is not so clear when the apex is treated. However, Fig. 16, A shows the promoting effect of apical treatment with $10^{-5}\%$ hetero-auxin on rooting. Minimum

TABLE 11.

Number of Rootlets (Ratio to Control) Formed on Segments Treated with Hetero-auxin (in Lower Concentrations) Apically or Basally. Results 16 Days after Beginning of Culture. Mean of 8–10 Segments.

Concentration of hetero-auxin (%)		10^{-5}	10^{-6}	0
Apical treatment	Basal 2/5–part	0.5	0.7	1
	Middle 2/5–part	4.0	3.5	1
	Apical 1/5–part	1.1	1.3	1
	Total	1.0	1.1	1
Basal treatment	Basal 2/5–part	0.9	1.3	1
	Middle 2/5–part	1.2	0.4	1
	Apical 1/5–part	1.8	1.3	1
	Total	1.3	1.1	1

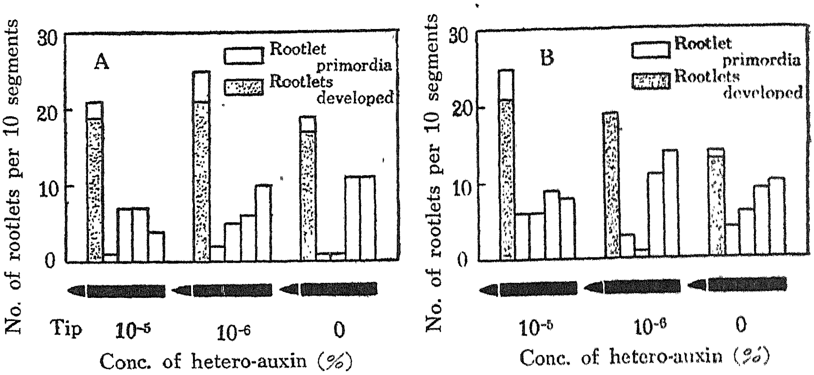

Fig. 15. Distribution of rootlets on root segments treated with hetero-auxin. A, apical treatment; B, basal treatment. Results 16 days after beginning of culture. Mean of 8–10 segments.

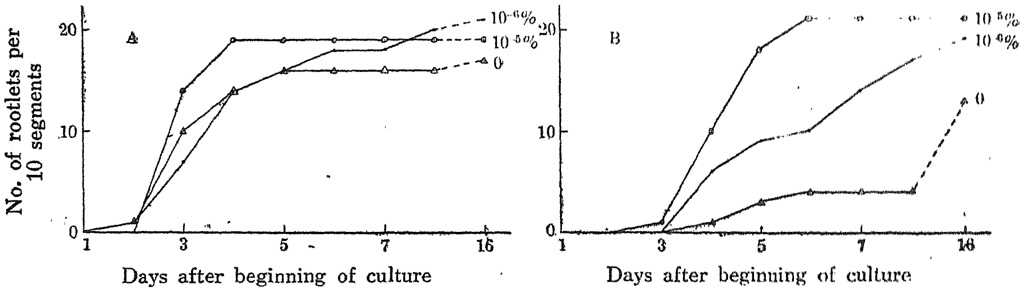

Fig. 16. Number of rootlets developed on root segments treated with 10^{-5}%, 10^{-6}% and 0% hetero-auxin. A, apical treatment; B, basal treatment. Mean of 8–10 segments.

effective concentration seems to be lower in basal treatment, but further experiments are needed for a definite conclusion.

DISCUSSION

De Haan ('36) reported that if an incision were made on one side of *Vicia Faba* roots, the formation of laterals would be prevented on the apical side of the incision for a considerable distance, because the "rhizocaline"[1] would be checked by the incision. Rippel ('37) discovered the following fact: If seedlings of *Vicia Faba* and other leguminous plants are cultivated after the removal of their cotyledons, lateral roots do not develop for 2–3 weeks, then the laterals appear on the root tip and the development proceeds slowly towards the base. He supposed that this phenomenon was responsible for a physiological gradient between cotyledons and root tip. At any rate the above facts indicate that the polar formation of laterals is related to something in the stem or cotyledons.

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[1] He used this term according to Bouillenne & Went ('33) in the sense of a substance which comes from the above part and is necessary for root formation.

KOTTE ('22) cultured 1 mm pieces taken successively from the tip of *Pisum* root and found that the second pieces (and in many cases the third also) formed one or more rootlets near the apical cut surface.

It has been found in the present work that the segments cut from various parts of the roots of *Pisum* seedlings form rootlets mainly near the apical end. Comparison of two successive segments taken from one root shows that the number of rootlets formed on the basal part of the apical segment is always less than the number of those formed on the apical end of the basal segment. These facts suggest that a factor (or factors) necessary for rootlet formation moves towards the apex of the segments and accumulates there. Further, it is assumed that a greater amount of the factor is present in the more apical parts of the root, because the number of apical rootlets is greater on the segments taken from the more apical parts of the root. In intact seedlings, being supplied with this factor continuously from the above part (perhaps cotyledons), the formation of laterals begins on the basal portion and proceeds acropetally according to the age of the tissue. That the number of rootlets formed on parts, other than the apical end of the segment, increases towards the base, and that they are formed in greater number on the segments taken from the more basal parts of the root, is explained also by considering the age of the tissue at the time when the segments were isolated.

It is an established fact that auxins promote the rootlet formation on roots as well as that on the above-ground parts. Treatment with heteroauxin increases the number of rootlets in the present experiments, too. This indicates that auxin is regarded at least as one of the limiting factors for the rootlet formation in the present case. The next question is whether auxin is the factor controlling the *polar* rootlet formation or not. There are at least three ways of explaining the polar rootlet formation on the segment: 1) auxin moves acropetally; 2) a factor (or factors) other than auxin is transported acropetally; 3) both auxin and the other factor or factors move towards the apex.

There are some factors other than auxin affecting the root formation on stems. (Cf. WENT & THIMANN '37.) But as few reports have so far been published regarding the influence of these factors on the rootlet formation on roots, we shall discuss only auxin, as follows.

The fact that, when either the apical or basal end of the root segment is treated with hetero-auxin, the effect is greater in both cases on the apical portion than on the basal portion of the segment, indicates that the hetero-auxin can be transported at least acropetally. Furthermore, the fact that the amount of native auxin present in roots increases towards the apex (THIMANN '34), considered in conjunction with the fact that the factor, assumed to be necessary for root formation and to move acropetally, seems to be distributed similarly, may suggest the possibility of the auxin being the controlling factor.

However, the movement of auxins in the root has been the subject of conflicting views. Regarding the transport of auxins applied externally, CHOLODNY ('34) and AMLONG ('39) showed only basipetal transport, while HEIDT ('31), GORTER ('32), FABER ('36), JOST & REISS ('37), WEILER ('38) and SYRE ('38) found both basipetal and acropetal transport. CZAJA ('35 b) and THIMANN ('36) also showed that auxin could be transported acropetally. On the other hand, GORTER ('32) reported that the most basal zones of roots 6–7 cm long transported practically no auxin. SYRE ('38) found that a greater amount of hetero-auxin was transported basipetally in the zone near the tips (zone 1–2 mm from tip in *Zea Mays*, zone 1–2.5 mm in *Vicia Faba*), while in the next zone (2–3.5 mm in *Zea*, 2.5–4.5 mm in *Vicia*) the transport occurred more readily towards the apex (in *Zea*) or was about equal in both directions (in *Vicia*). From these findings, it is probable that auxins applied externally can be transported in both directions.

Then, how does the movement of the native auxin in the root take place? Auxin in roots of seedlings is detectable by the diffusion method, within only several millimetres from the tip (BOYSEN JENSEN '33), and it seems to be transported basipetally in the elongating region of the root (NAGAO '36). By the extraction method, however, auxin is obtainable from the basal parts of the roots, too (THIMANN '34). VAN OVERBEEK ('39 a) found that even in the root-tip a part of the auxin was obtainable only by the extraction method. SYRE ('38) has shown that the amount of auxin in the decapitated root of *Vicia Faba* does not decrease for more than 60 hours, if the cotyledons are not removed.¹⁾ (However, BOYSEN JENSEN ('36) reported that the amount of auxin in

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¹⁾ The writer also has obtained auxin from the root stump of *Pisum sativum* 1 or 2 days after the decapitation, by the extraction method. But the auxin detectable by the diffusion method disappeared within a day after the decapitation.

the apical 4 mm zone of the decapitated root of *Vicia Faba* decreased after 19 hours to 1/5–1/10 of the initial amount.) SYRE concluded from his result that the cotyledons gave auxin or its precursor to the root, supporting the views of GORTER ('32), WENT ('32), THIMANN ('34) and FIEDLER ('36). On the other hand, isolated root-tips cultured in nutrient media produce (or activate) auxin (NAGAO '37 & '38, GUTTENBERG & SEGELITZ '38, SEGELITZ '38, OVERBEEK & BONNER '38, OVERBEEK '39 b). Auxin is found over the whole length of the roots grown in vitro (OVERBEEK & BONNER '38, OVERBEEK '39 b). Further, OVERBEEK ('39 b) found that, when these roots grown in vitro were decapitated and put back in fresh nutrient solution for a further week, the amount of auxin in the root did not decrease, if the formation of side roots did not occur. Recently, THIMANN & SKOOG ('40) have shown that auxin in *Avena* roots can be extracted by successive extractions with ether, for more than 3 months. They consider that auxin is liberated slowly from its bound form during this time.

The above facts reported by many investigators give us no definite conclusion about the movement of the native auxin in roots, except that auxin detectable by the diffusion method seems to be transported basipetally in the elongating region.

Thus, whether the polar formation of rootlets on the root segment is caused by the polar transport of auxin or not is still left an open question. To settle this problem, we need more knowledge of bound auxin and auxin precursor.

The present experiments in *Pisum* show that the development of rootlets[1] occurs in most cases only near the apical end of the segment. This can be explained by assuming again that a factor, or factors, necessary for the development moves acropetally. It is assumed that the rootlet primordia on the basal part of segments taken from the basal part of roots, can grow out at first owing to the presence of a certain factor, but that the development soon stops because the necessary factor moves away towards the apex where the rootlets begin to grow out next. Experiments in *Helianthus* may be explained similarly.

Whether the two processes, the formation of root primordia and its outgrowth, are controlled by a common factor or not is unknown. The fact that the treatment with hetero-auxin increases not only the number of rootlets formed but also the number and length of developed rootlets, indicates that the development of rootlets also has been influenced directly or indirectly by hetero-auxin.

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[1] The outgrowth of the root primordia into rootlets and the subsequent growth of the rootlets might be two different processes, but they are discussed as one process in the present paper.

SUMMARY

1. Root segments cut from various parts of the roots of *Pisum* seedlings were cultured under sterile conditions, and the formation and the development of rootlets on the segments were investigated.

2. The formation of rootlets on the root segment was polar, i. e., especially great numbers of rootlets were formed near the apical end of the segment. In parts other than the apex of the segment, the rootlets were more ready to be formed on the more basal parts. The number of the apical rootlets was greater on the segments taken from the more apical parts of the root, while the basal rootlets were greater in number on the segments cut from the more basal parts of the root; the total number of rootlets formed was greater on the more basal segments. The total number of rootlets formed on the segment cut into pieces was nearly equal to that on the intact segment.

3. To explain the polar root formation, a factor, or factors, necessary for the root formation and moving acropetally in the segment was assumed.

4. Previous treatment with hetero-auxin increased the number of rootlets formed on the segments. The effect of the hetero-auxin was greater on the apical part than on the basal part of the segment, not only when the apical end, but also when the basal end had been treated.

5. Whether auxin is considered to be the factor controlling the polar rootlet formation or not was discussed without coming to any definite conclusion.

6. The outgrowth of the roots was polar, i. e., the rootlets developed only near the apical end. Although, when the segments including the basal parts of the root material were cultured, rootlets developed also on the basal parts of the segments, the apical rootlets grew longer than the basal ones, which ceased to grow earlier.

7. Previous treatment with hetero-auxin increased the number and length of the rootlets developed.

8. To explain the polar development of rootlets a factor, or factors, necessary for the rootlet development and moving acropetally in the segment was assumed.

9. In *Helianthus*, unlike in *Pisum*, the rootlet development occurred

on the whole length of the root segment. However, in this case also, the rootlets were greater in number and length in the more apical parts of the segment.

The writer is greatly indebted to Prof. Dr. Y. YAMAGUTI for his kind directions in the course of this work.

REFERENCES

AMLONG, H. U. (1939): Untersuchungen über Wirkung und Wanderung des Wuchsstoffes in der Wurzel. Jah·b. f. wiss. Bot., **88**, 421.

BONNER, J. & ADDICOTT, F. (1937): Cultivation in vitro of excised pea roots. Bot. Gaz., **99**, 144.

BOUILLENNE, R. & WENT, F. W. (1933): Recherches expérimentales sur la néoformation des racines dans les plantules et les boutures des plantes supérieures. Ann. Jard. Bot. Buitenzorg, **43**, 25.

BOYSEN JENSEN, P. (1933): Über den Nachweis von Wuchsstoff in Wurzeln. Planta, **19**, 345.

—— (1936): Über die Verteilung des Wuchsstoffes in Keimstengeln und Wurzeln während der phototropischen und geotropischen Krümmung. D. Kgl. Danske Vidensk. Selsk., Biol. Medd., **13**, 1.

CHOLODNY, N. (1931): Zur Physiologie des pflanzlichen Wuchshormons. Planta, **14**, 207.

—— (1934): Über die Bildung und Leitung des Wuchshormons bei den Wurzeln. Ibid., **21**, 517.

CZAJA, A. T. (1935 a): Polarität und Wuchsstoff. Ber. d. D. Bot. Ges., **53**, 197.

—— (1935 b): Wurzelwachstum, Wuchsstoff und die Theorie der Wuchsstoffwirkung. Ibid., **53**, 221.

FABER, E. (1936): Wuchsstoffversuche an Keimwurzeln. Jahrb. f. wiss. Bot., **83**, 439.

FIEDLER, H. (1936): Entwicklungs- und reizphysiologische Untersuchungen an Kulturen isolierter Wurzelspitzen. Zeitschr. f. Bot., **30**, 385.

GORTER, C. J. (1932): Groeistofproblemen bij wortels. Diss. Utrecht.

GUTTENBERG, H. VON & SEGELITZ, G. (1938): Der Einfluss von Licht und Dunkelheit auf Wurzelwachstum und Wurzelbildung. Planta, **28**, 156.

HAAN, I. DE (1936): Polar root formation. Rec. trav. bot. néerl., **33**, 292.

HEIDT, K. (1931): Über das Verhalten von Explantaten der Wurzelspitze in nährstoffreien Kulturen. Arch. Exper. Zellforsch., **11**, 693.

JOST, L. & REISS, E. (1937): Zur Physiologie der Wuchsstoffe III. Zeitschr. f. Bot., **31**, 65.

KOJIMA, H. (1940): Über den Einfluss von Heteroauxin auf das Längenwachstum und die Zellteilung in der Wurzelspitze von *Pisum sativum*. (Japanese with German résumé) Bul. Sci. Fak. Terkult., Kyûsyû Imp. Univ., **9**, 18.

KOTTE, W. (1922): Wurzelmeristem in Gewebekultur. Ber. d. D. Bot. Ges., **40**, 269.

LEVAN, A. (1939): Cytological phenomena connected with the root swelling caused by growth substances. Hereditas, **25**, 87.

LINDNER, R. C. (1939): Effects of indoleacetic and naphthylacetic acids on development of buds and roots in horseradish. Bot. Gaz., **100**, 500.

—— (1940): Factors affecting regeneration of the horseradish root. Plant Physiol., **15**, 161.

NAGAO, M. (1936): Studies on the growth hormones of plants. I. The production of growth substance in root tips. Sci. Rep. Tôhoku Imp. Univ., Biol., **10**, 721.

—— (1937): Studies on the growth hormones of plants. III. The occurrence of growth substance in isolated roots grown under sterilized conditions. (Preliminary report) Ibid., **12**, 191.

—— (1938): Studies on the growth hormones of plants. IV. Further experiments on the production of growth substance in root-tips. Ibid., **13**, 221.

OVERBEEK, J. VAN (1939 a): Is auxin produced in roots? Proc. Nat. Acad. Sci., **25**, 245.

—— (1939 b): Evidence for auxin production in isolated roots growing in vitro. Bot. Gaz., **101**, 450.

—— & BONNER, J. (1938): Auxin in isolated roots growing in vitro. Proc. Nat. Acad. Sci., **24**, 260.

PLANT, W. (1940): The role of growth substances in the regeneration of root cuttings. Ann. Bot., N. S. **4**, 607.

RIPPEL, K. (1937): Umkehr der Seitenwurzelgenese bei Leguminosen als korrelative Störung. Ber. d. D. Bot. Ges., **55**, 288.

SEGELITZ, G. (1938): Der Einfluss von Licht und Dunkelheit auf Wurzelbildung und Wurzelwachstum. Planta, **28**, 617.

STOUGHTON, R. H. & PLANT, W. (1938): Regeneration of root cuttings as influenced by plant hormones. Nature, **142**, 293.

SYRE, H. (1938): Untersuchungen über Statolithenstärke und Wuchsstoff an vorbehandelten Wurzeln. Zeitschr. f. Bot., **33**, 129.

THIMANN, K. V. (1934): Studies on the growth hormone of plants. VI. The distribution of the growth substance in plant tissues. J. Gen. Physiol., **18**, 23.

—— (1936): Auxins and the growth of roots. Amer. J. Bot., **23**, 561.

—— & LANE, R. H. (1938): After-effects of the treatment of seed with auxin. Ibid., **25**, 535.

—— & SKOOG, F. (1940): The extraction of auxin from plant tissues. Ibid., **27**, 951.

WEILER, F. (1938): Das Verhalten der Wurzeln unter der Einwirkung von Wuchsstoffen der *Avena*- und der *Zea*-Koleoptilspitzen. Bull. internat. Acad. polon. Sci. et Let., Cl. Sci. Math. et Natur., Sér. B. I., 1.

WENT, F. W. (1932): Eine botanische Polaritätstheorie. Jahrb. f. wiss. Bot., **76**, 528.

—— (1939): Some experiments on bud growth. Amer. J. Bot., **26**, 109.

—— & THIMANN, K. V. (1937): Phytohormones. New York, 1937.

ZIMMERMAN, P. W. & HITCHCOCK, A. E. (1935): The response of roots to "root-forming" substances. Contr. Boyce Thompson Inst., **7**, 439.

ON THE NECTAR-CROPPING ACTIVITY OF AN ANDRENID, *HALICTUS KATOI* (IN LIT.), WIDELY DISTRIBUTED AT MT. HAKKÔDA[1]

(DIURNAL RHYTHM OF ACTIVITIES IN INSECTS AND ITS ENVIRONMENTAL CONDITIONS. NO. XI)

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(With 4 text-figures)

(Received June 10, 1942)

INTRODUCTION

It seems to be very interesting from the ecological point of view to investigate the activity of insects which inhabit in such special environments as plateau and high mountain. Of this problem it is worthy to mention that MOTOMURA (1938)[2] has denied the existence of correlation between the fatal upper limit of temperature and the distribution in altitude in the case of some grasshoppers.

In the Botanical Garden of the Mt. Hakkôda Botanical Laboratory of the Tôhoku Imperial University (Fig. 1), and in the season of August, we may observe many kinds of insects coming to the flowers of *Lobelia sessilifolia* to gather honey. This insect fauna seems to be rather simple. A Syrphid, *Bombus*, *Eristalomya tenax*, an Andrenid bee and *Halpe varia* etc. are among these insects. A Syrphid and *Bombus* come first to the flowers of *Lobelia* early in the

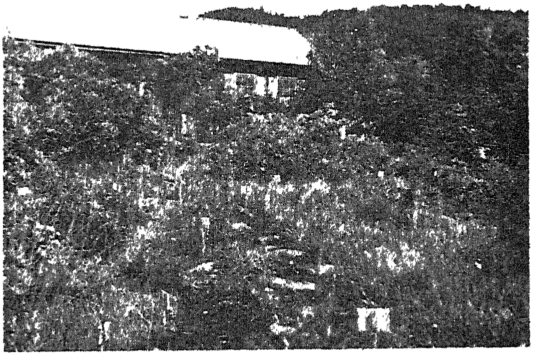

Fig. 1. A part of the Botanical Garden of the Mt. Hakkôda Botanical Laboratory.

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[1] Contributions from the Mt. Hakkôda Botanical Laboratory, No. 29.

[2] Lethal limit of high temperature in Orthoptera: Ecol. Rev., 4, 250–253.

morning, and they are succeeded by an Andrenid bee, *Halictus katoi* (in lit.)[1]. The activity of *Halictus* becomes suddenly vigorous by increasing the number of individuals, and thus this kind of bee becomes soon overwhelmingly great in number among the insects coming to the flowers of *Lobelia*.

In the present paper the writer should like to deal with the diurnal activity of this Andrenid bee, *Halictus katoi* (Fig. 2.). The nectar-cropping activity was taken as an index to denote the general activity and it was represented by the total number of the act of cropping nectar made by each bee visiting the flowers of *Lobelia*. There were found 15 plants of *Lobelia* making a group in the said Botanical Garden (Fig. 3).

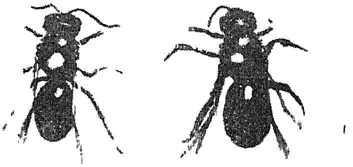

Fig. 2. *Halictus katoi;* left: male, right; female xca 2.0.

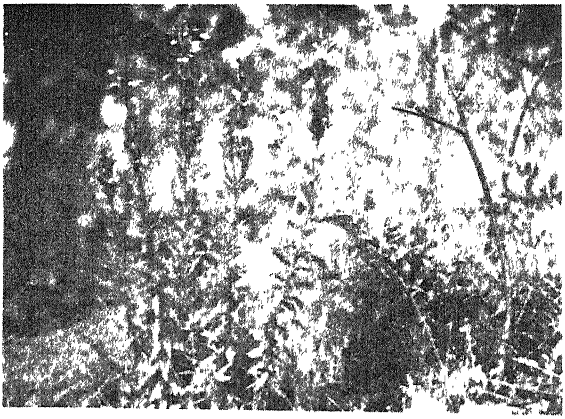

Fig. 3. A group of *Lobelia sessilifolia,* of which the present observation were made.

Of the environmental meteorological factors, the air temperature and the humidity were measured by ASMANN's Psychrometer, and a vaccum black heliothermometer was used, taking the solar radiant energy into consideration. The wind-direction was observed by the anemograph settled on the roof of the Laboratory, and the wind-intensity was measured with naked eye classifying into 7 classes. And the amount of cloud was also measured with naked eye.

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[1] This Andrenid bee was identified by Mr. K. YASUMATSU as a new species, and it will be published in near future under the specific name of *Halictus katoi*.

Before proceeding further the writer wishes to express his sincere thanks to Prof. Dr. YOSHIJI YOSHII, the director of the Mt. Hakkôda Botanical Laboratory, who gave him an opportunity to execute this investigation. The writer is gateful to Prof. Dr. SANJI HÔZAWA for his kind guidance and encouragement and to Assist. Prof. Dr. ISAO MOTOMURA for his valuable suggestions. An Acknowledgement is also due to the Foundation for Promotion of Industrial and Scientific Research in Japan for the financial help given to the writer.

TEMPERATURE LIMITS OF VARIOUS STAGES IN THE ACTIVITY OF *HALICTUS KATOI*

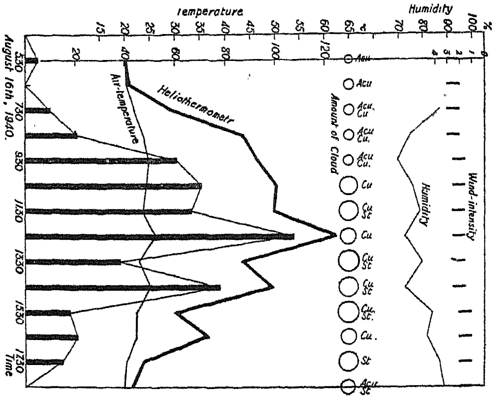
In the laboratory experiment, it is important to investigate first the relation existing between the activity and the temperature, in order to understand the activity of the said bee in the field. The laboratory experiment was executed according to MOTOMURA's method (MOTOMURA, 1938). After cooling the air temperature it was allowed to rise at the rate of 1°C. in every 3 or 4 minutes.

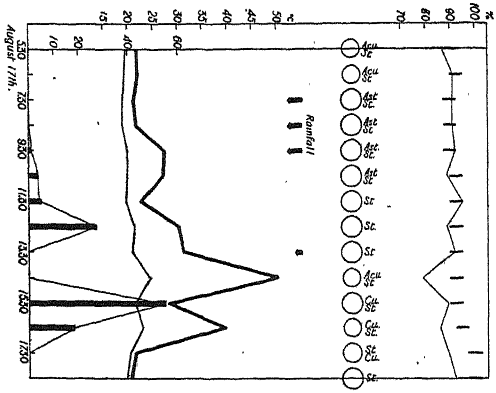
At 10°C. all bees are motionless with legs bended. At 12–14°C., they stand up on their legs and begin to perform the cleaning movement. They begins to crawl at 15–17°C., and the normal activity is seen at 20–22°C. and finally the flying activity becomes possible.

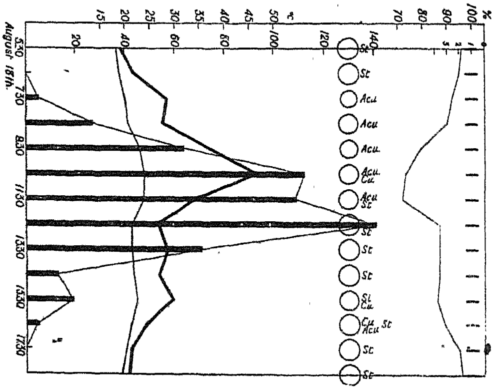
It is interesting to observe that the beginning of the normal activity is seen at the temperature fairly higher than that expected from their habitat and, accordingly, that the optimum temperature zone of activity is considered to be rather narrow. It seems, therefore, to be accepted that in such a plateau like the Hakkôda Botanical Garden, the time when they are active in a day and the period when they are active in the year should be rather short.

NECTAR-CROPPING ACTIVITY AND THE ENVIRONMENTAL CONDITIONS

The nectar-cropping activity of *Halictus katoi* visiting the flowers of *Lobelia* was observed in the Botanical Garden of the Hakkôda Botanical Laboratory, and the total number of said activities was counted during 5 minutes extending from 25 min. to 30 min. past each o'clock. The results thus far obtained were represented in Fig. 4.







I. *The Diurnal Rhythm of the Nectar-Cropping Activities.*

The observation was executed during 5 days extending from the 16th of August to the 20th of the same. The first individual was observed at 7th hour 30 min. in the morning. Though there was actually observed an Andrenid bee slightly active on a flower of *Lobelia* at 5th hour 30 min. of the 16th day, it did not arrive there at that time leaving its nest, but spent one night resting on that flower of *Lobelia* and became active, influenced by the sunshine of the morning. After 7th h. 30 min. the said activity becomes steadily greater, and thus reaches its climax about at noon. After 17th h. 30 min. *Halictus* ceases to come to the flower; and some bees, which have lost the chance to go back to their nest, become thus motionless and pass over the night remaining on the flower. Judging from the above facts *Halictus katoi* is considered to be a diurnal insect.

II. *The Relation Between the Activity and the Environmental Condition.*

1) It is obviously seen from Fig. 4 that the nectar-cropping activity expressed by this kind of bee correlates closely with the reading of the black heliothermometer and of the air temperature and seems therefore to be remarkably influenced by the environmental temperature factors. The highest temperature of 5 days measured at 5th h. 30 min. was 21.8°C. of the heliothermometer and 20.2°C. of the air temperature, and the lowest temperature was 18.3°C. and 16.9°C. respectively.

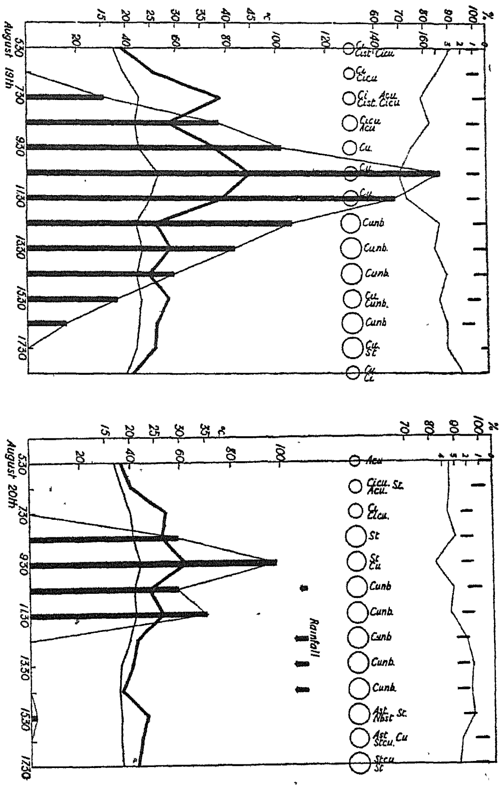


Fig. 4. Diurnal variation of the nectar-cropping activity of *Helictus katoi* and its environmental conditions. Claud-class; Ci: *Cirrus*, Cist: *Cirrostratus*, Cicu: *Cirrocumulus*, Acu: *Altocumulus*, Ast: *Altostratus*, Atcu: *Stratocumulus*, Nbst: *Nimbostratus*, Cu: *Cumulus*, Cunb: *Cumulonimbus*, St: *Stratus*.

Considering from the above mentioned experiment executed concerning the temperature limits of various stages of the activities, these environmental conditions seem to be suitable for the nectar-cropping activity of this kind of insect, but may not be favourable for the flight. It is accordingly quite natural that no flying bees were observed at 5th h. 30 min. of the 16th day, though an individual which passed over the night resting on a flower began to crop nectar at that time. During these 5 days the first bee which came flying to the flower was observed at 26.2°C. of the heliothermometer and at 19.9°C. of the air temperature. But in the mean temperature measured from the records obtained every day the first flight was seen at 30.3°C. and 21.0°C. respectively. The lowest temperature, when the ending of the said activity in the evening was observed, was 23.4°C. of the heliothermometer and 18.1°C.

of the air temperature; and in the mean temperature obtained from the measurements of each day, the activity ended respectively at 25.5°C. and 21.0°C. The fact above mentioned is conceivable from the experiment made in the laboratory, in which the temperature limit of normal activity, viz., the beginning of the flight is observed at 20–22°C.

2) From the relation of the fluctuation of the temperature factors to the increase and decrease of the activity, it is found that the nectar-cropping in the morning is not so active in spite of the favourable temperature environement, namely the increasing curve of the activity seems to lag in time behind that of the temperature factors. This may be more or less depend upon the progression of time spent in the flight made from the nest to the flowers.

3) In the present paper the writer did not allude to whether the light intensity influences upon the said activity or not. In the morning and in the evening the light intensity seems to be an important factor to the said activity, but it will be understood that the light intensity may not be important in the daytime to the said activity. It is, however, necessary to inquire into the correlation existing between the said activity and the light intensity.

4) Lundie (1925)[1] reported that the rainfall restrict the activity of the honeybee. In the case of *Halictus katoi* the nectar-cropping activity is also restrained by rain, even by a misty rain. At 13th h. 30 min. of the 17th day, in spite of the favourable temperature environment, the said activity was interrupted, being influenced by the misty rain. On the 20th day, during the time extending from 12th h. 15 min. to 15th h. 10 min., the shower interrupted the activity perfectly, and moreover it was so strong that 7 individuals, which were working on the flowers, lost the chance to go back to their nest and was constrained to rest quietly even after the rain stopped, influenced by rain drops and by decreased temperature. This interruption of the activity caused by the rain seems, indeed, to be of entirely mechanical.

5) The influence of the wind given upon the activity of the said bee was also recognized. The relation between the flight of the honeybee and the wind investigated by Lundie (1925). In the case of *Halictus katoi* the influence of the wind is seen when the observation made on the 16th day of August is compared with those of the 18th and 19th day of the same. For the said bee the temperature environmental conditions was found more favourable in the 16th day than in the 18th and 19th

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[1] The flight activitis of the honey bee: Unit. St. Dept. Agric. Bull., No. 1328.

day, but the nectar-cropping activity was obviously vigorous in both of the 18th and 19th. Comparing the wind-intensity in these two cases, it is recognized that it was 2-3 in the 16th day, but it was 0-1 during both days of the 18th and 19th. Considering from the fact above mentioned, it may be generally accepted that the light wind may somewhat control the flight of the bee, and thus they influence upon the said nectar-croping activity.

SUMMARY

1. The present paper deals with the nectar-croping activity of an Andrenid bee, *Halictus katoi* (in lit.), widely distributed at the Botanical Garden of the Mt. Hakkôda Botanical Laboratory of the Tôhoku Imperial University, in relation to the environmental meteorological conditions.

2. In the slowly rising temperature environment, this bee begins to crawl at 15–17°C. and shows the normal activity at 20–22°C. becoming capable to fly.

3. This bee is obviously one of the diurnal insects and a close correlation was recognized to exist between the activity and the environmental temperature factors. The first Andrenid flying from the nest to the garden was seen in the morning at 26.2°C. of the reading of the heliothermometer and at 19.9°C. of the air temperature. The last individual flying in the evening was observed at 23.4°C and 18.1°C. respectively.

4. The said activity is interrupted even by the misty rain; it is also influenced by the wind, being weakened even by the light wind.

ON THE BLOOD CORPUSCLES AND THE BLOOD FORMATION IN *PHORONIS*

(THE 13TH REPORT OF INVERTEBRATE HEMATOLOGY)

By

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(With 17 Text-figures)

(Recieved June 10, 1942)

The anatomy and histology of the genus *Phoronis* have been studied by such authors as BENHAM (1889), CORI (1891), IKEDA (1901), BROOKS and COWLES (1905), DE SELYS-LONGCHAMPS (1907), etc. There has, however, been no recent and detailed work on the blood corpuscles and the blood forming organs. As was stated by SCHULTZ (1903), these animals possess a peculiar character to abandon their lophophores by autotomy, if they are fed under unfavourable conditions. The lost parts, however, are completely regenerated when they are kept under ordinary circumstances. To study the change occurring in the blood during these bodily revolutions aroused my special interest.

The material consists essentially of *Phoronis australis* HASWELL, but I have made some supplementary observations using the sections prepared of *Ph. ijimai* OKA, too. The former kind of species was obtained in the vicinity of the Seto Marine Biological Station of the Kyôto Imperial University. Owing to the difficulty in collecting fresh material, I had to use the old specimens of *Ph. ijimai* which were collected about twenty years ago in the neighborhood of the Misaki Marine Biological Station of the Tokyo Imperial University, and preserved in formol fluid.

My investigation was aided by a grant from the Japan Society for the Promotion of Science, for which I should like to express my deep appreciation. The observations using the living specimens were made at the Seto Marine Biological Station, during the summers of 1937 and 1938. It is a pleasure to express my hearty thanks to the gentlemen of the staff of that station for their generous help and encouragement. I should like to take this occasion also to express my sincere appreciation to Prof. Dr. S. HÔZAWA for his kindness expressed in reading the manuscript in spite of all his active life.

OBSERVATIONS

I. Erythrocytes.

The blood was readily drawn off from the perivisceral cavity by means of a small hypodermic needle. The erythrocytes are usually spherical and are in the form of slightly biconvex disc with smooth contour and rounded edge. The cells measured in the state of suspension showed such a less remarkable amount of variation in size as 8–12 micra in diameter and 2–4 micra in thickness. The nucleus is, at first, usually obscure from sight, owing to the density of the blood pigment, as in the case of the red cells of other invertebrates, but it becomes clearer during the protracted observation. The nucleus is rather small and of a rounded or oval shape, and is located eccentrically. Excepting the nearly constant presence of a single or double nucleoli, the nuclear contents are not discernible in unstained preparations. The cytoplasm of fresh and unstained corpuscles is usually homogeneous but there exist, usually one or two, occasionally three or more granules which are highly refractive. They are brown or greenish brown in colour, and are located in the perinuclear region. These granules are easily stained supravitally with any of Nile-blue sulphate, neutral red, brilliant cresyl blue, etc. When the red cells are exposed supravitally in Janus green B, some granular or fibrillar structures will appear within a few hours, being distributed irregularly throughout the cell.

The fine cellular structures which are positive to the silver impregnation were demonstrated in the present specimens, using the method of Tomita and others. The type of the impregnation pattern is quite similar to that of the red cells of *Caudina* and *Molpadia* (Ohuye, 1936).

In dry fixed smears stained by Giemsa's method. the nucleus of a full grown cell is small and spherical or oval in form, provided with the chromatin network rather rough. In the young erythrocytes, the nucleus is large in size, and its diameter reaches one third or one forth of the cell diameter. The chromatin granules are very fine and are densely filled up within the nucleus or arranged in a cart wheel shape. The cytoplasm is, needless to say, eosinophilically stained, but there are seen the successive stages of polychromatophilism in the young red corpuscles. The refractive granules are basophilic, and appear as purple coloured bodies.

It is generally believed that the pigment found in the red corpuscles is one kind of hemoglobin. The only author who doubted this view was Bethe (1927). My experiment done using the methods of Lepehne and

OKAJIMA, the specific staining for hemoglobin, was in favor of the accepted view, which would be further confirmed by the fact that the red corpuscles of *Phoronis* are almost invariably positive to the copper-peroxidase reaction of SATO and SHOJI. By the counting chamber method proposed by these authors it was found that the red corpuscles contain a varying number of blue or bluish green granules or crystals, which are the positive sign of this reaction (Fig. 1). In this case most of the cells have blue needle-shaped crystals protruding from their bodies. The nucleus and the refractive granules found in the cytoplasm also react positively. MINAGAWA (1937 a) reported that the frog's erythrocytes show different or the whole stages of peroxidase pictures in the cytoplasm and in the nucleus. He (1937 b) also made a success in demonstrating the peroxidase positive granules of human red cells in the cases of severe anemia. SUZUKI (1938) obtained a similar result using the normal human blood. He concluded that there is a close morphological relations between hemoglobin and peroxidase. The ferment-like properties of hemoglobin or of its derivatives were recently discussed by several biochemists such as LANGENBECK 1935, HAUROWITZ 1937, KEILIN & MANN 1937, etc. I think that the positive result of SATO and SHOJI's reaction to the red cells may be due to the presence of hemoglobin, because the reaction is also positive even after the blood has been heated in order to enervate the peroxidase which may possibly exist in the red cells.

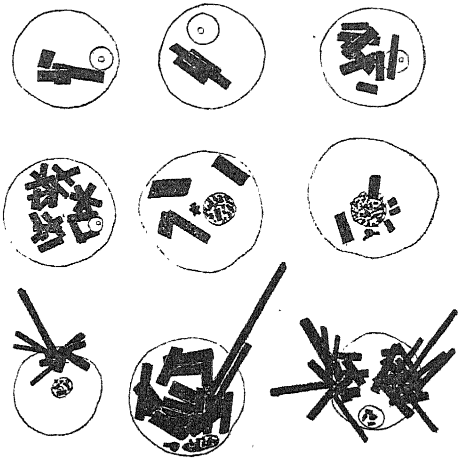

Fig. 1. Peroxidase positive erythrocytes of *Phoronis*. ca. ×1000.

II. Leucocytes.

In the blood of *Phoronis* we find five kinds of formed elements: a) hyaline amoebocytes, b) eosinophilic granulocytes, c) basophilic granulocytes, d) cells with RUSSELL bodies, and e) spindle bodies.

a) Hyaline amoebocytes. These are the cells provided with hyaline cytoplasm, set in active amoeboid movement, and existing in abundance next to the red cells in the blood of *Phoronis*. Among these cells, three subtypes of different size are distinguishable together with some transitional forms. The smallest one is 4–8 micra in diameter, and is provided with a scanty amount of cytoplasm and a nucleus of comparatively large rounded or oval form. The medium sized one is 10–12 micra in diameter, and is similar to the smallest in cellular structure. The nucleus is any of oval-, bean-, pear-, or U-shaped. Among the scanty amount of cytoplasm there can be seen, upon rare occasions, one or two fine granules, located close to the nucleus. The largest one measures about 15–20 micra in diameter. The nucleus is comparatively small in size, and is any of round, oval or rod-like in form. It is usually located eccentrically. The median and the largest should be included within the histiocyte or the macrophage, judging from their function and origin, which will be discussed below. As is mentioned above, these cells are set in an active movement, protruding thin, broad and membranous pseudopodia (Fig. 2). In the largest type it is seen a vigorous ingestion of India-ink, and there exist very frequently senile erythrocytes, usually one, but on rare occasions two or more, and some number of spindle bodies are also found ingested in the cytoplasm. The number of oxidase- and peroxidase-granules found in the cytoplasm is usually proportional to the activity of ink ingestion.

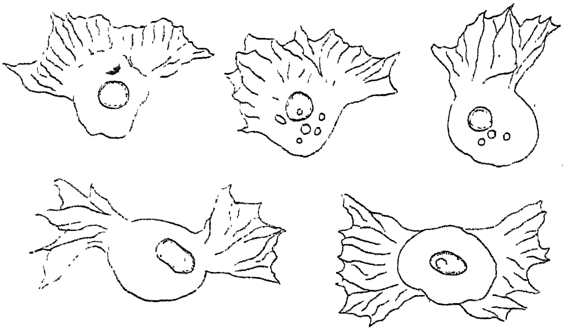

Fig. 2. Hyaline amoebocytes with membranous pseudopodia. ca. ×1000.

b) Eosinophilic granulocytes. These exist in abundance next to the hyaline amoebocytes, and the subtypes may be distinguished: one with fine granules and the other with coarse granules. The cytoplasm of the former kind of granulocytes is filled up with fine, colourless granules, of 1–2 micra in diameter. The granules of the latter kind of granulocytes are remarkably irregular in size, being 2–6 micra in diameter. Among the coarsely granulated granulocytes some cells with one or several green or brown granules are infrequently met together with the cells of ordinary type. The granulocytes of both types are nearly equal in size being 10–16 micra in diameter, and are actively amoeboid in movement and moreover are positive to the phagocytosis. It is noteworthy that there are found some differences in pseudopodia between the hyaline and granular leucocytes. The pseudopodia emitted by the former, as is mentioned above, are thin and membranous, while those by the latter are comparatively thick and petaloidal (Fig. 3). The eosinophils are positive to the oxidase and peroxidase reaction.

c) Basophilic granulocytes. These are very rarely met with. Their sizes and structures are quite similar to those of the finely granulated eosinophilic leucocytes, though they are less active in phagocytosis, amoeboid movement and so forth.

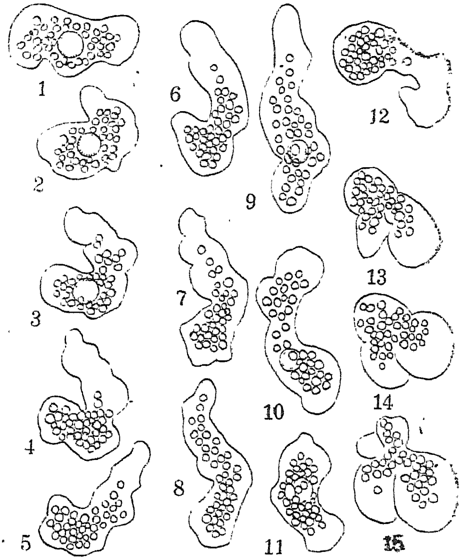

Fig. 3. A granulocyte in the successive stages of amoeboid movement. ca. ×1000.

d) Cells with Russell bodies. The Russell body cells are said to be free lymphoid cells containing numerous eosinophilic mulberry-like globules. Since the discovery of these cells by W. Russell (1890) in the normal and pathological tissues of men and mammals, there have been made innumerable investigations on their enigmatic properties. There have been found, however, no records concerning those of invertebrates practically, so fas as I am aware of. I have found numerous cells of this kink in the perivisceral fluid and among so-called adipose tissues of *Phoronis australis* and *Ph. ijimai.* The Russell body cells of *Phoronis* are either round or oval in shape, without any emitting pseudopodia (Fig. 4). The size of each of these cells varies greatly. All transitional stages can be found ranging from cells of the size of erythrocyte to the elements several times larger. The nucleus is comparatively small, being either round or oval in shape, and occupies an eccentric position, showing more or less the signs of degeneration. The cytoplasm surrounding the granules is usually baso-

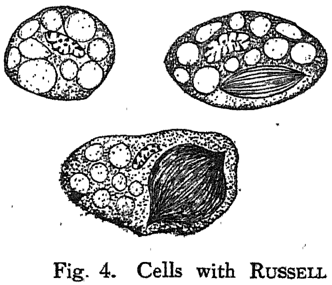

Fig. 4. Cells with Russell bodies. Two cells possess ingested spindle body. ca. ×800.

philic or amphophilic with basophilic inclination. The RUSSELL bodies are spherical, ovoidal or angular in shape, and are strongly and homogeneously stained with eosin. Occasionally the cell-membrane is ruptured and the inclusions come out freely to distribute among the tissue. There are found frequently some RUSSELL body cells which have one or two spindle bodies ingested within their cell bodies. The chemical property of the RUSSELL body is still uncertain. A number of suggestions have been made; and it is said to be any of fibrin (PELAGATTI 1897), lecithin (LUBARSCH 1897), amyloid (DANTSCHAKOFF 1906), myeline (MILLER 1910) and hemoglobin (JORDAN and SPEIDEL 1929, DAWSON 1929, KINDRED 1932, etc.). MICHELS (1935), reviewing this problem, seems to be inclined to support the last view as the most substantiated, though he is still in question whether the various micro-chemical tests of hemoglobin is invariably and absolutely specific or not. In my experiment the RUSSELL bodies occasionally showed a positive sign to the hemoglobin reactions of LEPEHNE and OKAJIMA, and also to SATO and SHOJI's, and thus it makes me to believe the hemoglobin hypothesis. In regard to the RUSSELL bodies, the tests for iron were made by several authors. KEASBY (1923) obtained the positive reaction of iron discrimination in the case of eosinophilic RUSSELL bodies. The results obtained by CHUMA (1923) and MICHELS (1935) were opposite to hers. In the case of the present specimens I have failed to detect the iron from the RUSSELL bodies, using the methods of PEARL and MACCALLUM. The RUSSELL bodies were insoluble in any of ether, alcohol, chloroform, benzol, etc. In various dilute mineral acids they had not shown any remarkable change, though they were soluble in a solution of n/10 NaOH. The reactions of MILLON, MOLISCH, biuret, and ninhydrin were negative. BEST's carmine and ruthenium red stained the bodies very slightly, showing a doubtful existence of glycogen. Trials to stain the bodies with Sudan III and Sudan IV, and the detection of cholesterin with digitonin ended in a failure. The RUSSELL body cells showed the positive sign of nadi-reaction and that of copper-peroxidase.

e) Spindle bodies. Of *Phoronis psammophila* CORI (1891) found so-called spindle bodies, first described by KOWALEVSKY, and which are not only freely floating in the coelomic cavity but are also found within the adipose tissue. IKEDA (1903) reported the existence of this body in the coelomic fluid of *Ph. australis*, but he had never encountered this body within the adipose tissue. Furthermore he had never come across in the case of *Ph. ijimai*. In my present observation the spindle bodies were always found abundantly in the body fluid and within the adipose tissue of the both species of *Phoronis*. The spindle bodies are found to be increased remarkably in number if one keeps the animal under the unfavourable conditions.

III. Vital staining.

As to the vital dyes, I have used principally sodium-carmine and trypan blue. The detailed prescription of dyes are seen in my foregoing paper (OHUYE 1934).

a) Erythrocytes. The red corpuscles do not show any alternation beyond becoming faintly and diffusely tinged with trypan blue when there is a large amount of vital dye in the plasm. By the supravital staining one or several neutral red bodies are demonstrable. A prolonged exposure to the dye causes the appearance of numerous induced granules. The brown granules, which are located in perinuclear region and are easily seen in the fresh and unstained cells may be slightly stained by the supravital staining using any of neutral red, neutral violet, Janus green B, brilliant cresyl blue, etc..

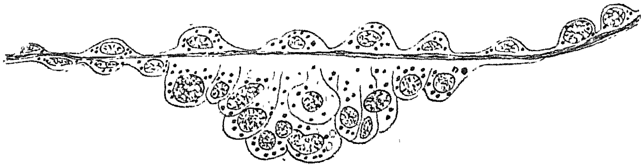

Fig. 5. The wall of fine blood vessel, showing hypertrophied and vitally stained adventitious (upper) and endothelial (lower) cells. ca. ×800.

b) Leucocytes. All leucocytes except the spindle bodies are positive to the vital staining. The most intensive one is, of course, the macrophage, and the next is the hyaline amoeboid cells. The eosinophils react also vigorously to the vital dyes. The RUSSELL body cells also ingest the dyes, but there are some gradations of the amount of ingested granules.

If India-ink be injected in the blood, this substance is quickly taken up by the leucocytes, and thus it is usually found that the most of the hyaline and granular leucocytes contain the granules of India-ink.

By repeated injection of dyes or ink, the stimulation types of cells such as macrophages, transitional forms, etc., increasingly appear in the circulating blood.

c) The endothelium of blood vessels. In the case of higher vertebrates, it is said that the cells which line the blood and lymph vessels take up the dyes only after very prolonged and intense administration, and even then, only very minute granules which are visible with high magnification can take up those dyes. In the present specimens, however, all these cells are very active in the vital staining (Figs. 5 & 6). The vital dye-granules are remarkably large and numerous, and are easily detected in the fixed and counterstained tissues. By the repeated injection of dyes they become hypertrophic, and are proloiferated into the vascular lumen.

The adventitious cells of blood vessels behave quite similarly (Fig. 5).

d) Adipose tissue. So-called adipose tissue, surrounding the lower part of alimentary tract, strongly ingests the vital stains of all kinds, and the results of vital staining have a close resemblance to those of bone marrow of the vertebrates. After the rapid intense staining with trypan blue or carmine, the dye is deposited in the form of fine granules within the endothelial cells of the venous sinusoids. As the vital staining increases in intensity, a great number of relatively large dye granules appear in the cytoplasm of adipose cells which contain several large vacuoles. Injection of India-ink leads to the vital staining of adipose tissue which is similar to that obtained with soluble dyes.

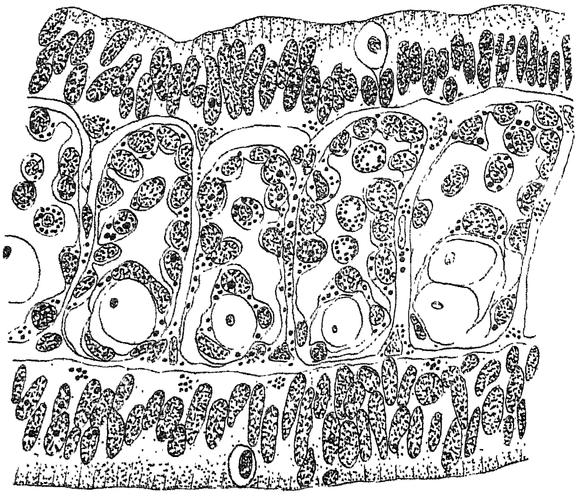

Fig. 6. Cross section of a tentacular basis, vitally stained with carmine. Endothelial proliferation is visible. ca. ×800.

e) Peritoneum and mesentery. These are also the loci easily stainable with vital dyes. The cells covering the peritoneal surface or those forming mesentery store the vital dyes in a characteristic manner (Figs. 7 & 8). The intracellular dye granules appear first forming a small group near the nucleus, and as the staining proceeds, the number of granules increases and the group assumes the shape of a crescent or complete ring encircling the nucleus. The cells which are usually in the shape of lens, become plumped and rounded, and some of them are proliferated into the coelomic cavity (Fig. 8).

f) Alimentary tract. The staining of the alimentary tract is due chiefly to the presence of some vitally stained histiocytes in the intestinal tissues. It is, however, seen frequently that the vital dye granules are excreted through the epitherial wall of intestines (Fig. 8).

g) Nephridium. The cells of nephridial tube ingest copious vital dyes.

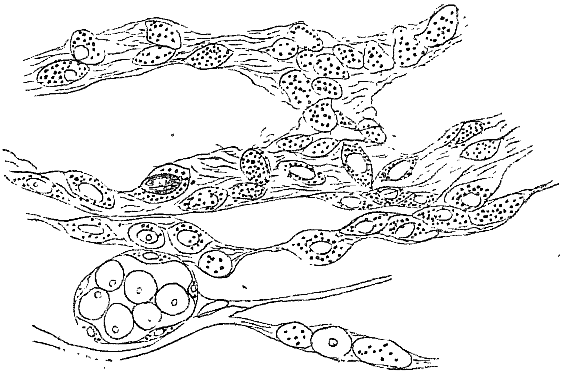

Fig. 7. Vitally stained mesentery. Fresh and spread preparation. ca. ×600.

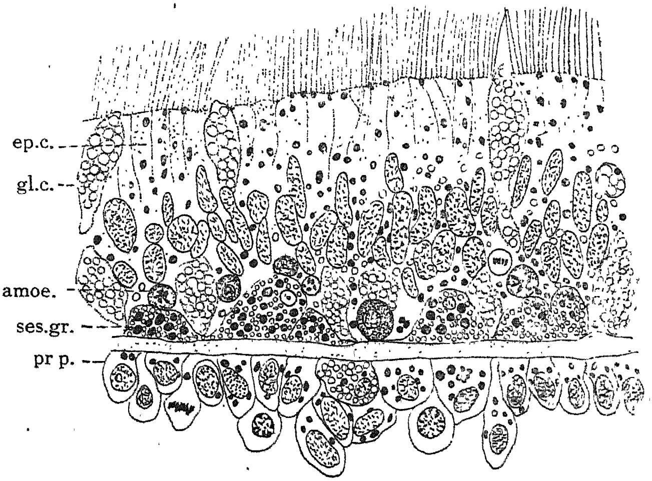

Fig. 8. A part of intestinal wall, vitally stained with carmine. Carmine granules being excreted from the epithelium. Splanchnic peritoneum shows remarkable hypertrophy. ca. ×600: ep.c., epithelial cells; gl.c., glandular cells; amoe., amoebocytes; ses.gr., sessile granulocytes; pr.p., proliferating peritoneum.

IV. Hemocytopiesis.

Caldwell (1882–83), touching upon the origin of the blood corpuscles of *Phoronis*, said that the corpuscle masses arise from the mesoblastic cells located in front of the septum, but he said nothing further about their position or origin. Ikeda (1901) described the blood corpuscles as arising from the gigantic mesoblastic cells found in the body cavity of the larvae with one or two pairs of tentacles. Menon (1902) thinks that the blood corpuscles arise from the splanchnopleure covering the stomach and its diverticulum. According to CORI (1891), the blood corpuscles which are to be seen in the adult are formed from the endothelium of the blood vessels. DE SELLYS-LONGCHAMPS (1907) states that the red cells (he makes no description on the white blood corpuscles) multiply by direct division which occurs among the circulating blood. BROOKS and COWLES (1905) observed that the blood corpuscles are present in the so-called collar in the form of masses which are more or less closely attached to the ventrolateral walls of the stomach. The present investigation has been undertaken in the hope of finding some specific locus of hemopoiesis, of which, as is seen in the short review just aforementioned, there is not any decisive opinion at present. The hemopoietic loci of *Phoronis* are as follows:

a) Endothelium. As is stated by CORI, the endothelium of the blood vessels is the essential locus of erythrocytopoiesis. The endothelial cells which line the peripheral fine vessels where the blood streaming is liable to stagnate show always the phenomena of hypertrophy and the subsequent proliferation (Fig. 6 & Figs. 9–12). The endothelial cells, which are usually flat and are a little protruded into the lumen of vessels, become first rounded and larger, then they take the shape of pear and are connected with the basal membrane by means of their slender ends. The stalks of cells grow gradually and become more slender. At last, the stalks are detached from the wall of vessel, and the cells become quite free (Figs. 9 & 12). In proportion to the growth of cell body, the nucleus increases in its volume and becomes round in shape. The chromatin substance is distributed in the form of coarse net-work. The cytoplasm which surrounds the nucleus in the form of a narrow ridge is homogeneous and basophilic. The isolated endothelial cells may take two directions of differentiation — the erythrocytopoiesis and leucocytopoiesis, and the former is overwhelmingly intensive than the latter in the peripheral and fine vessels.

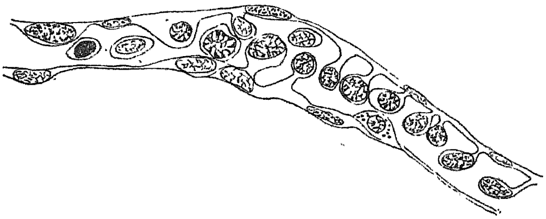

Fig. 9. Longitudinal section of a fine blood vessel. Showing endotherial proliferation. ca. ×600.

In the fields of endothelial proliferation, two kinds of nuclei will be seen, the light and loose one on one side, and the dark and compact one on the other. The ordinary cells of endothelium possess the nucleus of the former type. Corresponding to the gradual darkening of nuclear tone, some alternation of nuclear structure sets forth. The chromatin substance divides into numerous, triangular fine granules arranged regularly, giving a sieve-like appearance. The cell in this stage should be called the basophilic erythroblast or proerythroblast. This cell begins to change into polychromatophilic erythroblast with gradually increasing hemoglobin. The chromatins show more or less radiating arrangement. Such arrangement of chromatins, however, is disturbed by increasing hemoglobin deposition, and the nuclear contents become progressively compact and homogeneous, in proportion to the increasing acidophily of the cytoplasm. The cytoplasm is decreased in volume by repeated cell division, and the cell becomes about one half of the basophilic erythroblast in diameter. The cells in this stage should be called as normoblasts. They are found most abundantly in fine blood vessels (Fig. 11). The normoblast becomes erythrocyte by increasing the volume of cytoplasm and by decreasing the same of nucleus. The description just aforementioned is applied to

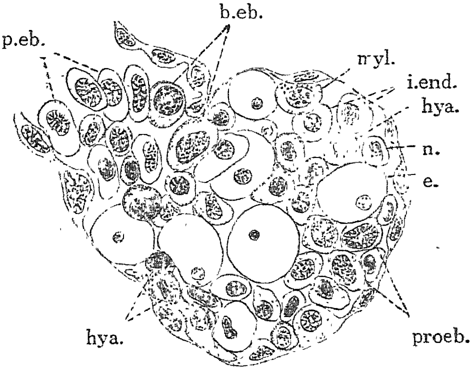

Fig. 10. Blood sinusoid containing various young stages of blood corpuscles. ca. ×800: i. end., isolated endotherial cells; myl., cells of myelocyte-type; b.e.b., basophilic erythroblasts; p.e.b., polychromatophilic erythroblasts; n., normoblasts: e., matured erythrocytes; hya., hyaline amoebocytes.

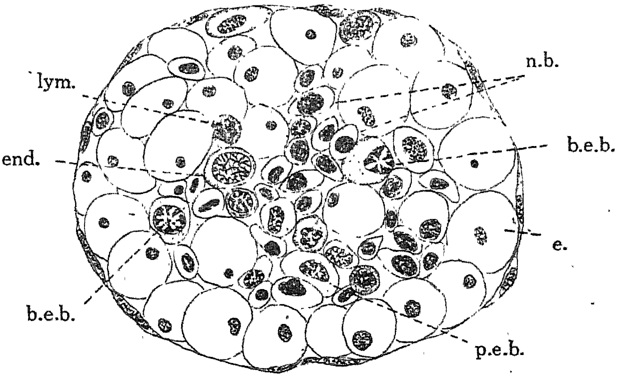

Fig. 11. Blood sinusoid containing numerous normoblasts. ca. ×800. The abbreviations are the same as Fig. 10.

the orthodex erythrocytopoiesis. There is a short cut of the red cell formation which is rather more frequently met with. That is, the endothelial cells which are originally similar to normoblast in size are proliferated and thus become the normoblasts with progressive deposition of hemoglobin in the cytoplasm.

SABIN (1921) made an excellent investigation on the blood corpuscles of chick embryo. According to her, the granules stainable supravitally with neutral red or brilliant cresyl blue are massive and completely fills the cytoplasm of the red cells in the early stages; then as the cytoplasm increases the granules remain in a rosette or wreath around the nucleus making the erythroblast; a little later it begins to sproud out in the cytoplasm making extensive reticular forms. These successive changes of the granules are seen of the developing red cells in the case of the present specimens. A single or several greenish brown granules peculiar to the invertebrate erythrocytes already begin to appear in the basophilic erythroblasts, locating closely to the nucleus. These granules show a reaction to dyes which is quite similar to the reaction of nucleus in the early stages of red cells, suggesting the close relation existing between the granules and the nucleus.

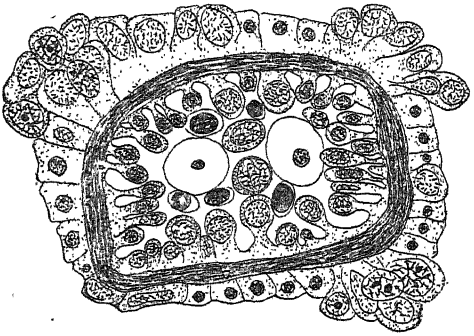
Fig. 12. Cross-section of blood vessel, showing adventitious and endothelial proliferations. ca. ×800.

The endothelial cells also become leucocytes. Most of the endothelial cells possess the characteristics of so-called endothelial leucocytes or histiocytes, and the rest have the properties of lymphocytes. I was not able to trace the granulopoiesis in the vascular endothelium.

The adventitious cells of vessels show also a good deal of proliferation (Figs. 5 & 12), and it is frequently rather more intensive than in the case of the vascular endothelium. They show an active reaction to the vital staining. The adventitious cells are usually larger than those of endothelium. The direct formation of the normoblast is never seen in this locus. By the vital staining with neutral red, all of the adventitious cells show that they bear granules stainable with this kind of dye, being scattered throughout the cell body. These pluripotential cells are capable of becoming either erythroblast or histiocyte, the development of the former being described just above. In the cells protruded into the body cavity are found the vacuoles characteristic of the histiocyte (Fig. 5). These cells are set free from the wall to form the essential part of the leucocytes.

The adventitious cells give rise to the granulocytes, too. The cells which correspond to the promyelocyte of the higher vertebrates are to be seen in the proliferating locus. They have large, round nucleus which shows somewhat oxyphilic inclination and frequently possess one or two nucleoli (Fig. 12). The chromatin substance is distributed in the shape of coarse and angular reticulum. In the cytoplasm which is basophilic when fixed and stained, numerous granules are detectable. They are variable in size, round in shape, more or less acidophilic and are clustered close to the one pole of the nucleus. In the young granulocytes the neutral red granules produced by supravital staining are arranged like a cluster near the nucleus while those of the erythrocytes are arranged around the nucleus. With the advance of metamorphosis the cytoplasm of the young granulocytes progressively grows acidophilic, and a number of large, round and acidophilic granules begin to appear, and are scattered throughout the cell. To trace the formation of basophilic granulocyte ended in a failure in the cace of the present work.

b) Mesothelium. This is also one of the important loci of hemopoiesis. For the mesothelium which has the potency of blood cell formation may be enumerated the followings: — splanchnic and somatic peritonea, mesenteries and the cell layer lining the lumen of tentacles. These are intensely positive to the vital staining with soluble and colloidal dyes. The marked hypertrophy and subsequent proliferation are visible after repeated dye injection. These proliferated cells may be the stem cells of various blood corpuscles. This fact may be easily demonstrated, using the method of supravital staining with neutral red, brilliant cresyl blue, etc. But the trial to detect further development ended in a failure, except the lumen of tentacles where the mesothelial cells are transformed into normoblasts (Fig. 6). Most of the proliferated cells migrate into the body cavity as the histiocytes, showing active phagocytosis. The remaining may enter into the blood vessels and adipose tissues, and perform their metamorphosis there.

c) Adipose tissue. The name "adipose tissue" (Fettgewebe) was first adopted by KOWALEVSKY (1871). DE SELYS-LONGCHAMPS (1907) used this term. too. CORI (1891) recognized this tissue as "vasoperitoneal tissue"

(Gefässperitonealgewebe). For the reason that the cells of the tissue under consideration arise from the peritoneum, and surround the outer surface of the fine vessels which are found in the perivisceral cavity, as is seen in Fig. 13, this name should be preferred by him. Ikeda (1903) called this tissue "nutriment layer", owing to the richness of yolk-like substance. These names seem to make clear the characteristics of the tissue. It is evident that this tissue lodges the genital organs in it, and innumerable mitotic figures of spermato- and ovogeneses are seen, during the period of reproduction. Cori pointed out that this kind of tissue serves as a hemocatatonistic organ, and there are found many disintegrating cells, such as red cells and spindle bodies. It seems curious to me that Ikeda did not mention any of these spindle bodies in this tissue. In adition to these functions the adipose tissue may be, I believe, a hemopoietic organ, too. To encounter the normoblasts in this tissue is rather common (Fig. 13). The granulocytopoiesis is also seen in this region. In some vaso-

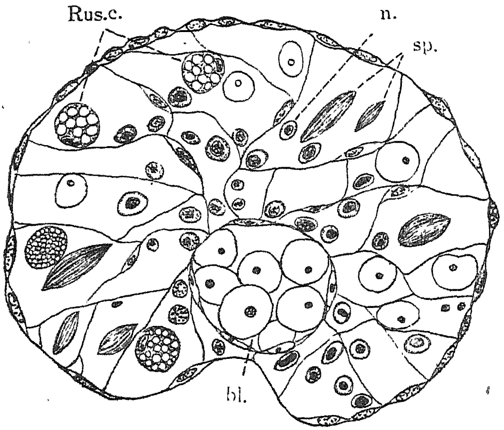

Fig 13. Vasoperitoneal tissue. bl., blood vessel with erythrocytes; n, normoblasts; Rus. c., Russell body cells; sp., spindle bodies. ca. ×800.

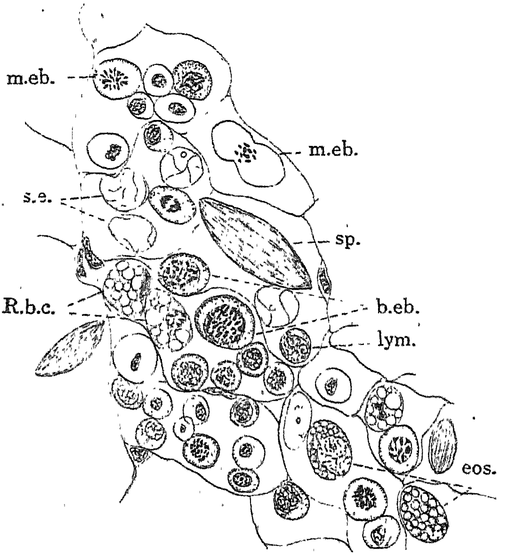

Fig. 14. Vasoperitoneal tissue in which hemopoiesis is seen. m.eb., mitotic erythroblasts; eos., eosinophils; Rus.c., Russell body cells; sp., spindle bodies; b.eb., basophilic erythroblasts; lym., lymphocytes; s.e., senile erythrocytes. ca. ×800.

peritoneal cells in which the adipose degeneration does not yet begin, the granules peculiar to the promyelocyte appear in the perinuclear cytoplasm (Fig. 14). These cells become eosinophilic granulocytes, accompanied by typical evolution, the detailed description of which may be found in the text books of hematology.

As is mentioned above, the cells with RUSSELL bodies are found abundantly in this kind of tissue (Figs. 13 & 14). The exact process of formation of this cell still remains obscure. I think, however, a part of RUSSELL body cells arises from the vasoperitoneal cells which ingest senile erythrocytes and their débris. There are found many vasoperitoneal cells in which the fragments of erythrocytes are detectable and the successive denaturation of these fragments is advancing (Fig. 14). These spectacles concerning the adipose tissue remind me the metaplastic bone marrow of the vertebrate. I am sorry that I could not found any fact with regard to the formation of basophilic granulocytes.

SCHULTZ (1903) made a detailed observation on the autotomy of *Phoronis* and on the succeeding regeneration occurring in the same. I have repeated the same observation from the stand-point of hematology. The results were rather simple, and the most remarkable change which drew my attention was very intensive peritoneal proliferation (Figs. 15–17). A part of these proliferated cells migrates into the wound and is used

Fig. 15.

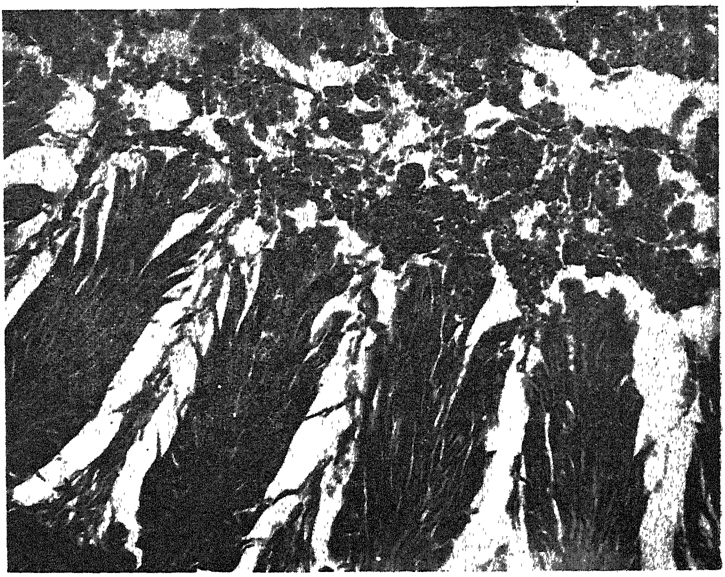

Fig. 16.

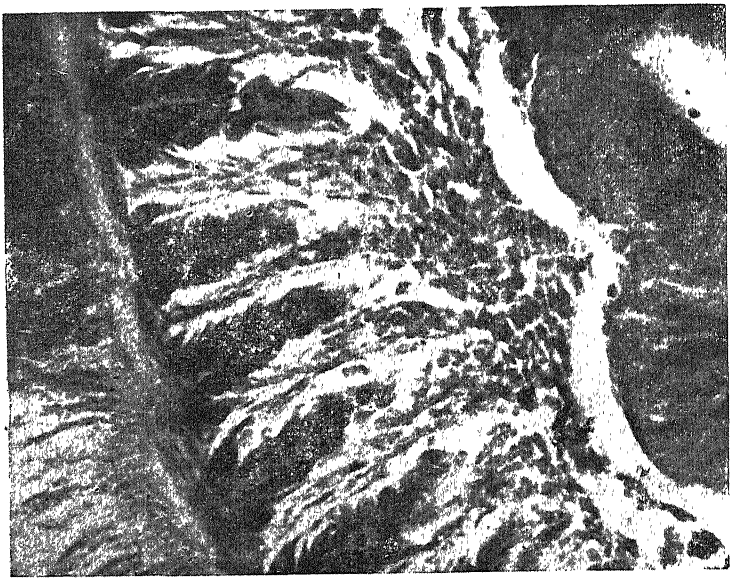

Fig. 17.

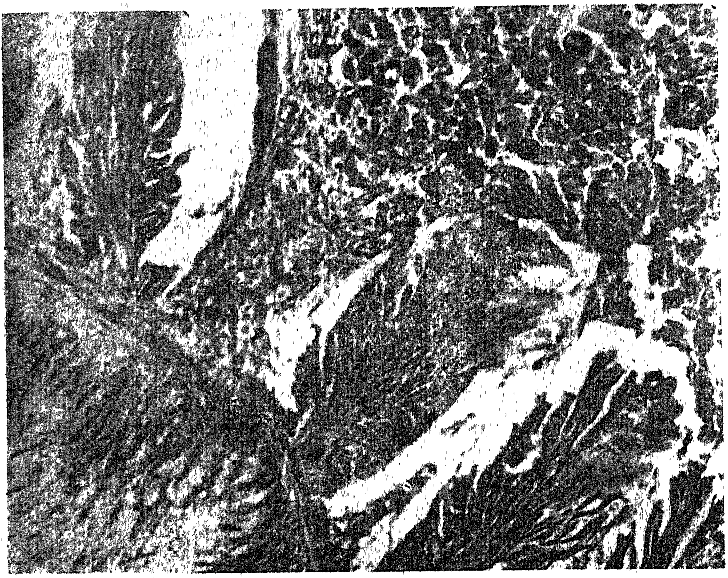

Fig. 15–17. Peritoneal proliferations by the regeneration, showing varying intensity of proliferations. ca. ×400.

up for the regeneration. The remaining aggregates to form a relatively compact mass in the perivisceral cavity and comes to have some close relation to the adipose tissue. In this cell mass the differentiation of blood corpuscles takes place gradually. Of this fact I made a detailed description in the foregoing section. The spindle bodies are found especially abundant in the cell mass. This fact seems to suggest the origin of these bodies. The proliferation of reticulo-endothelial system becomes also more intensive during the regeneration in comparison with that of normal animals.

From the above statement it is evident that any specific hemopoietic organ is not found in the present specimens, but the hemopoietic process are very similar to those of the vertebrates, and also that the hemopoiesis is performed by means of the cellular proliferation of reticulo-endotherial system. In the case of the vertebrates such intensive proliferations of endothelial and mesothelial tissues are only seen in the pathological condition. The compensating hemopoiesis of the reticulo-endothelial system following the extirpation of the spleen was reported by such authors as JORDAN and SPEIDEL (frogs, 1923; *Triturus*, 1930), WITUSCHINSKI (Axolotl, 1928), OHUYE (Japanese newt, 1932) DAWSON (*Necturus*, 1933), etc. In Amphibia the spleen is the most important organ of the hemopoiesis, and the removal of this organ from the adult animals means the deprival of the whole of hemopoietic centre. Thus the compensating hemopoiesis may begin in the widely distributed reticulo-endothelial system. In *Phoronis* there is, needless to say, neither spleen nor specially differentiated hempoietic organ at all. Accordingly the view that the normal hemopoiesis is performed by the scattering reticulo-endothelial cells seems to be rather natural and reasonable, as is the case of the early embryonal stage of vertebrates. Thus we can recognize in the present animal the primitive stage of hemopoiesis which evolutionally antecedes that of the vertebrates. The adipose tissue may be, I suppose, the precursor of specific hemopoietic organ such as the bone marrow of the vertebrates.

SUMMARY

1. In the blood of Phoronis, the following kinds of corpuscles are found: a) erythrocytes, b) hyaline amoebocytes, c) eosinophilic granulocytes, d) basophilic granulocytes, e) cells with RUSSELL bodies, and f) spindle bodies.

2. These cells except the last one are all positive to the reactions of oxidase and peroxidase.

3. The RUSSELL bodies are positive to the reactions of LEPEHNE and

OKAJIMA, showing their hemoglobiniferous nature. Iron reaction, however, was negative.

4. The leucocytes and the cells of the endothelium and mesothelium are intensely stainable with various vital dyes.

5. The endo- and mesothelium are the important loci of the blood formation. Cellular proliferation and various cellular metamorphosis are seen in these tissues and in the lumens lined with this kind of tissues.

6. The successive stages of erythrocytopoiesis and granulocytopoiesis are to be traced using SABIN's method of supravital staining.

7. A vigorous peritoneal proliferation is seen by the regeneration following the autotomy. A part of these proliferated cells is transformed into the blood corpuscles.

8. The normal hemopoietic manner of *Phoronis* is quite similar to that of Amphibia which are deprived of any essential hemopoietic organs.

LITERATURE CITED

BENHAM, W. B., 1899. The anatomy of *Phoronis australis*. Q. J. Micr. Sci., Vol. 30, pp. 125–158.

BETHE, A., 1927. Eigentümliche Formen und Mittel der Blutbewegung (*Phoronis, Tomopteris, Squilla*). Z. f. vergl. Physiol., Bd. 5, S. 555–576.

BROOKS, W. K. and R. P. COWLES. 1905. *Phoronis architecta:* its life history, anatomy and breeding habits. Mem. of Nat. Acad. of Sci., Vol. 10, pp. 97–100.

CALDWELL, W. H., 1882–83. Preliminary note on the structure, development and affinities of *Phoronis*. Proc. Roy. Soc., Ser. B, Vol. 34.

CHUMA, M., 1923. Zur normalen und pathologischen Histologie der Magenshleimhaut. VIRCHOWS Arch. Bd. 247, S. 236–277.

CORI. C. J , 1891, Untersuchungen über die Anatomie und Histologie der Gattung *Phoronis*. Z. f. wiss. Zool., Bd. 51, S. 480–568.

COWLES, R. P., 1904. Origin and fate of the blood vessels and blood corpuscles of the Actinotrocha. Zool. Anz., Bd. 27, Nr. 19.

DAWSON, A. B., 1933. An experimental study of hemopoiesis in *Necturus:* Effects of lead poisoning on normal and splenectomized animals. J. Morph., Vol. 55, pp. 349–384.

—— 1935. Hemopoietic response in the cat fish, *Ameiurus nebulosus,* to chronic lead poisoning. Biol. Bul., Vol. 68, pp. 335–346.

IKEDA, I., 1901. Observations on the development, structure and metamorphosis of Actinotrocha. J. Coll. Sci., Tokyo Imp. Univ., Vol. 8, part 4, pp. 507–592.

—— 1903. On the development of the sexual organs and of their products in *Phoronis*. Ann. Zool. Jap., Vol. 4, pp. 141–153.

JORDAN, H. E. and C. C. SPEIDEL, 1923. Effect of splenectomy, experimental hemorrhage, and hemolytic toxin in the frog. Am. J. Anat., Vol. 32, pp. 155–187.

—— 1930. The hemocytopoietic effect of splenectomy in the salamander, *Triturus viridescens*. Ibid., Vol. 46, pp. 55–90.

KEASBY, L., 1923. On a new form of leucocyte (Schollenleukozyt, WEILL) as found in the gastric mucosa of the sheep. Fol. Hematol., Bd. 29, S. 155.

KEILIN, D. and T. MANN, 1937. On the hematin compound of peroxidase. Proc. Roy. Soc., Ser. B, Vol. 122, pp. 119–133.

KOWALEVSKY, A., 1867. Anatomy und Entwicklungsgeschichte von *Phoronis*. St. Petersburg.

MICHELS, N. A., 1935. Medullary and non-medullary erythropoiesis with special reference to the plasma-cell, erythophage or RUSSELL body cell, and to the erythrocatheric (erythrolytic) function of lymph nodes and hemal nodes. Am. J. Anat., Vol. 57, pp. 439–496.

MINAGAWA, T., 1937 a. Copper peroxidase reaction of frog's red cells: A morphological demonstration of close relation between peroxidase and hemoglobin. Tôhoku J. Exp. Med., Vol. 30, pp. 398–404.

—— 1937 b. Morphological demonstration of close relation between hemoglobin and peroxidase in human blood. Ibid., pp. 405–409.

OHUYE, T., 1932. Hemocytopoietic effect of splenectomy in the newt, *Diemyctylus pyrrhogaster*. Sci. Rep. Tôhoku Imp. Univ., Ser. Biol., Vol. 7, pp. 49–63.

—— On the coelomic corpuscles in the bodv fluid of some invertebrates. I. Reaction of the leucocytes of a holothurid, *Caudina chilensis* to vital dyes. Ibid., Vol. 9, pp. 47–52, 1934. VII. On the formed elements in the body fluid of some marine invertebrates which possess the red blood corpuscles. Ibid., Vol. 12, pp. 203–239, 1937.

RUSSELL, W., 1890. An adress on a characteristic organism of cancer. Brit. Med. J., Vol. 2, p. 1356.

SABIN, F. R., 1922. On the origin of cells of the blood. Physiol. Rev., Vol. 11, pp. 38–69.

SCHULTZ, E., 1903. Aus dem Gebiet der Regeneration. III. Über Regenrationserscheinungen bei *Phoronis mülleri*. Z. f. wiss. Zool., Bd. 57, S. 391–420. IV. Über die Regenerationserscheinungen bei *Actinotrocha branchiata*. Ibid., S. 473–494.

DE SELYS-LONGCHAMPS, M., 1907. *Phoronis* (Fauna und Flora des Golfes von Neapel und der angrenzenden Meeres-Abschnitt: 30 Monogr.). Berlin.

SUZUKI, T., 1938. Peroxidase-positive erythrocytes and normoblasts in human blood under the copper peroxidase reaction. Normal erythrocytes made peroxidase-positive: Further morphological evidence of close relation between peroxidase and hemoglobin. Tôhoku J. Exp. Med., Vol. 34, pp. 32–37.

WITUSCHINSKI, V., 1928. Hāmatopoese beim Axolotl nach Milzexstirpation. Z. f. Zellenforsch. u. mikr. Anat., Bd. 6, S. 611–630.

ON THE BLOOD CORPUSCLES AND THE HEMOPOIESIS OF A NEMERTEAN, *LINEUS FUSCOVIRIDIS*, AND OF A SIPUNCULUS, *DENDROSTOMA MINOR*[1]

(THE 14TH REPORT OF INVERTEBRATE HEMATOLOGY)

By

Toshio Ohuye

Biological Laboratory of Matsuyama Higher School, Ehime-Ken

(With 7 Text-figures)

(Recieved June 10, 1942)

I. *Lineus fuscoviridis* Takakura

There seems to remain much to be done in the study of the blood corpuscles of the Nemertini. This report deals with the results of the investigation on the blood corpuscles of a Nemertean, *Lineus fuscoviridis*, which was made during the summer of 1940.

As to the terminology, the " red and white blood corpuscles " are used in the present work, corresponding respectively to the " blood corpuscles " and " rhyncocoelomic corpuscles " used in Bürger's classification (1890, '95) in the cases of the free cells found in the blood vessels and coelomic cavities. The former kind of corpuscles is red in colour and is elliptic disc in form, provided with no pseudopodium and being exclusively found in the circulatory system, while the latter kind of corpuscles is colourless and amoeboid in movement, and frequently contain several yellow or red granules in their cytoplasm. This classification was also adopted by Riepen (1933) in his study on *Malacobdella grossa.*

(1) Red Blood Corpuscles.

The red blood corpuscles of the present animal show in various respects a close resembrance to those of two Holothurians, *Caudina* and *Molpadia.* The corpuscles freshly taken are of rounded or oval, flattened disc, measuring about 12–20 micra in diameter. When viewed separately, each of these corpuscles does not appear red, but a pale yellow tinge. As seen in the cases of *Caudina* and *Molpadia* (Kawamoto 1927, Ohuye 1936), the corpuscles change their form gradually when removed from the animal

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[1] The cost of this research has been defrayed from the Scientific Research Expenditure of the Department of Education for which I should like to express my indebtedness.

body. Under microscope, the cell, first seems to swell a little, then takes the shape of a pear or of V-, Y-letter, etc. (Fig. 1). One or more of spine- or bristle-shaped processes are frequently sent forth from the cell surface. The branching of processes was not observed in any specimen.

The cytoplasm of corpuscles is almost homogeneous, and lodges one or more of refractive granules of 1–2 micra in diameter, and of yellowish brown colour, usually situated in the vicinity of the nucleus. The granules are stainable supravitally with neutral red, brilliant cresyl blue, Janus green B. etc., and show a positive reaction to the test of oxidase and peroxidase. The rounded or oval nucleus is, at first, obscure in the cells freshly taken, but it becomes clearer if one keeps the corpuscles under observation for some time, as in the case of the erythrocytes of other invertebrates. By the prolonged observation under the microscope, usually single, occasionally two or three small vacuoles which are stainable with supravital dyes appear within the cytoplasm.

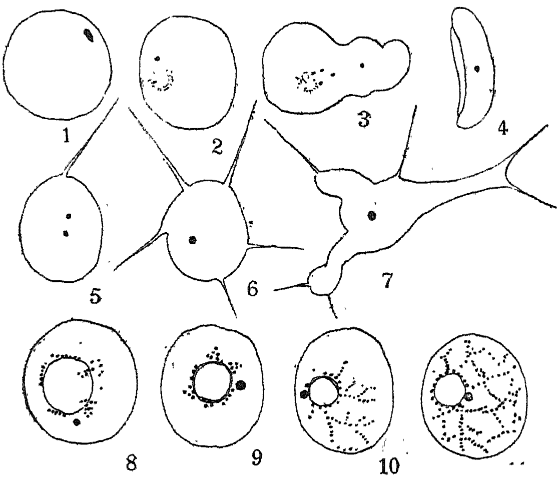

Fig. 1. Erythrocytes of *Lineus*. ca. ×1100. 1–7, fresh and unstained. 8–11, supravitally stained with Janus green B.

The present author has reported in his previous papers (OHUYE, 1936, '37, '38) on the presence of neutral red bodies in the cytoplasm of the red blood corpuscles of various invertebrates. Using SABIN's method, the neutral red bodies of from one to several number, are also demonstrable in the perinuclear zone of *Lineus* erythrocytes. The supravital staining with Janus green B. brings out initially a small number of perinuclear granules frequently arranged in short rods. They take a reticular arrangement with their increase in number (Fig. 1). By means of brilliant cresyl blue a similar result may be also obtained.

As in the cases of *Caudina* and *Molpadia*, the brown refractive granules of the red cells show a positive sign of nadi-reaction. To the copper-peroxidase method of SATO and SHOJI these granules also react positively. The granules are stained greenish blue and gradually increase in their volume. Besides the granules the whole cytoplasm of the red blood corpuscles shows an intensive reaction to the test of peroxidase. In the cytoplasm first appear greenish blue granules. They become numerous of tabular or needle-shaped crystals, and frequently penetrate through the cell membrane, giving a sea-urchin-like appearance to the cell.

In applying GIEMSA's staining of dry-fixed smears the nucleus becomes very distinct. The nuclei of the full-grown erythrocytes are small in size and are composed of fine and densely aggregated chromatin granules. In young erythrocytes or erythroblasts, the nuclei are relatively large and the chromatins take an arrangement of lattice-work (Fig. 2). The cytoplasm of erythroblasts shows basophilic or polychromatophilic staining. Occasionally the microerythrocytes, which are one half or less than that of the ordinary erythrocytes in diameter, are met with. The refractive granules are stained basophilically, and are found already in the basophilic erythroblast.

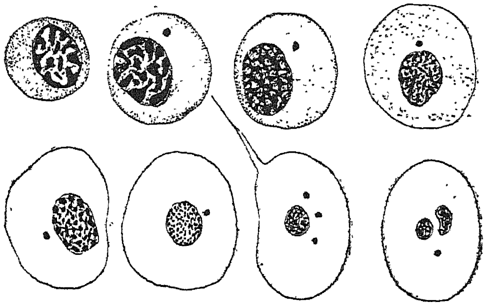
Fig. 2. Various stages of erythrocyte-development. (Stained by GIEMSA's method.) ca. ×1100.

(2) White Blood Corpuscles.

Of the white blood corpuscles the following four kinds of cells may be distinguished; a. hyaline amoebocytes, b. eosinophilic granulocytes, c. basophilic granulocytes, and d. spindle bodies.

a. Hyaline amoebocytes. This type of cell shows no special difference from those of other invertebrates. As Fig. 3, 1–5 show, this is a perfectly homogeneous cell, and measures about 6–12 micra in diameter when it takes a round shape. The hyaline amoebocytes are actively amoeboid and phagocytic, and show an intensive reaction to the vital staining. The nadi-reaction is strongly positive while the reaction of copper-peroxidase is absolutely negative. In the smears stained by GIEMSA's method, the nucleus shows no particular arrangement of chromatin granules.

b. Eosinophilic granulocytes. Among this kind of cells the following three subtypes are distinguishable: i) cells with fine granules, ii) cells

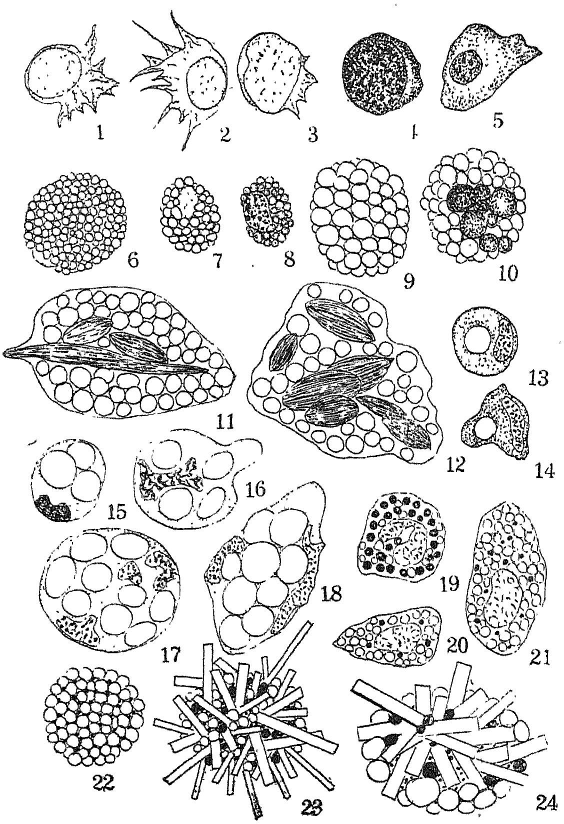

Fig. 3. Various kinds of leucocytes of *Lineus*. ca. ×1100. Explanation of figures is seen in the text.

with coarse granules, and iii) cells with Russell bodies.

i. Cells with fine granules. These cells are very frequently met with, measuring about 8–14 micra in diameter, and containing a number of fine, eosinophilic granules of about 1–2 micra in diameter (Fig. 3, 6–7). The nucleus is usually hidden by these surrounding granules, but it becomes apparent when the staining of Giemsa is applied. The nucleus is eccentric and flattened, and the chromatin structure is not distinct. The granules show strong affinity to the supravital dyes, such as neutral red, brilliant cresyl blue, Nile-blue sulphate and so forth.

ii. Cells with coarse granules. These are in size nearly equal to or a little larger than the erythrocyte, and their cytoplasm is fully filled with coarse granules measuring 1–4 micra in diameter (Fig. 3; 9–12). These are liable to be mistaken for the isolated glandular cells, but these show an intensive phagocytosis and it is easily seen, in fact, that one, two or several of spindle bodies are ingested in the cytoplasm of the present cells (Fig. 3, 11–12). Green, yellow or brown granules are also found in the cell bodies occasionally (Fig. 3, 10). By the microscopic observation they vividly take carmine or India-ink in their cytoplasm supravitally. The nucleus, usually hidden by granules, is oval or flattened and occasionally eccentrically located. The granules are stained supravitally with neutral red, brilliant cresyl blue and so forth. Oxidase granules appear in intergranular cytoplasm.

Both cells of type i. and ii. are positive to oxidase and peroxidase reactions (Fig. 3, 19–24). In the copper peroxidase reaction of SATO and SHOJI, some greenish blue granules appear, at first, in the intergranular cytoplasm. With the advance of the reaction, the ordinary granules also begin to be stained with the reagent. In many cases the needle-shaped or tabular crystals which are seen in the erythrocytes by the peroxidase reaction appear in the cytoplasm of the present cells (Fig. 3, 23–24), and it gives also the sea-urchin-like appearance to the cells, as seen in the case of erythrocytes.

iii. Cells with RUSSELL bodies. These cells, when fully grown, are similar to the cells of type ii. in size and appearance. They contain eosinophilic granules or rather globules in the basophilic cytoplasm (Fig. 3, 13–18). The number of granules is, however, much smaller than the cells of type ii, and therefore one, two, or rarely three nuclei, flattened and eccentrically located, are easily seen in fresh and unstained preparation. They are non-amoeboid and non-phagocytic. The reactions of oxidase and peroxidase are positive in the cases of these cells, but are not very intensive.

c. Basophilic granulocytes. There are small (8–10 micra in diameter) cells rarely met with, containing numerous granules (Fig. 3; 8). The granules are stained basophilically by GIEMSA's method, but metachromatic property was not discernible. The present author has failed to detect the reactions of oxidase and peroxidase of these cells.

d. Spindle bodies. No fundamental difference was found between these bodies and those of other invertebrates.

From the above description it may be evident that the formed elements found in the present animal show a close resembrance to those of Holothuroidea, Sipunculus, Phoronidea, Brachiopoda, etc., all of which possess the red blood corpuscles. Thus the blood of *Lineus* seems to belong to a rather advanced type among the invertebrate animals.

II. *Dendrostoma minor* IKEDA

The erythrocytes of the present animal are similar to those of *Physcosoma scolops* (OHUYE, 1937) in many respects, but the total absence of crystals is worthy to be noted. They are to be found very frequently in the erythrocytes of the latter kind of animal. The erythrocytes show considerable variation in size, ranging 8–20 micra in diameter. Usually one, occasionally two or three brown granules are found in the perinuclear region, and they are the only structure of the erythrocytes which is positive to oxidase and peroxidase reactions. Except the lack of urn and

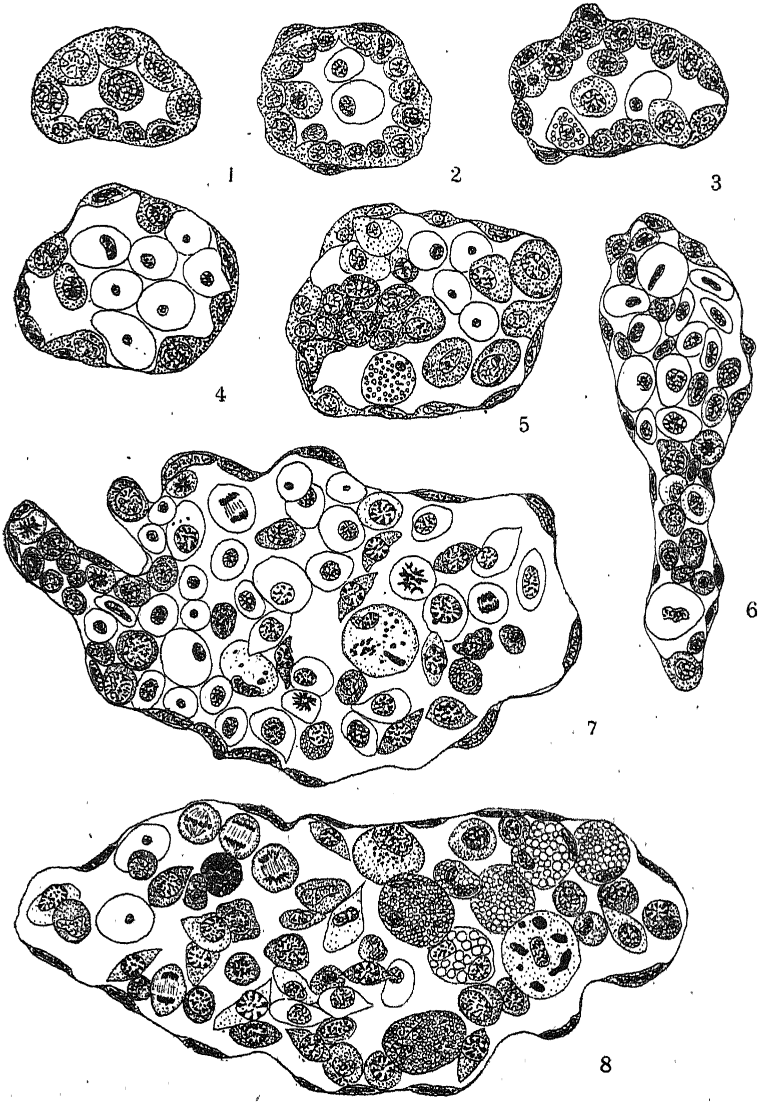

Fig. 4. Cross-section of a blood vessel at different levels. The active hemopoiesis are seen. ca. ×700.

spindle body, the leucocytes of *Dendrostoma* show also no significant difference from those of *Physcosoma.* Such coincidence in the characteristics of the blood corpuscles is not to be wondered at, in view of the close systematic relation existing between these two animals.

Because of its small size (about 20 mm. in body length) the present animal affords a nice material for the study of hemopoietic locus by means of total serial sections. This field of study still remains obscure of various lower invertebrates. The following observations are essentially based upon the serial sections prepared of the whole animal bodies, fixing with ZENKER's fluid and staining with either eosin-hematoxylin or GIEMSA's stain.

In *Phoronis*, the endothelium, mesothelium and adipose tissues should be enumerated as the essential hemopoietic loci. Though in the present animal, as in *Phoronis*, the endo- and mesothelium — especially the former —play a most important role of hemopoiesis. It must not be forgotten to count also the circulating blood as one of the hemopoietic loci.

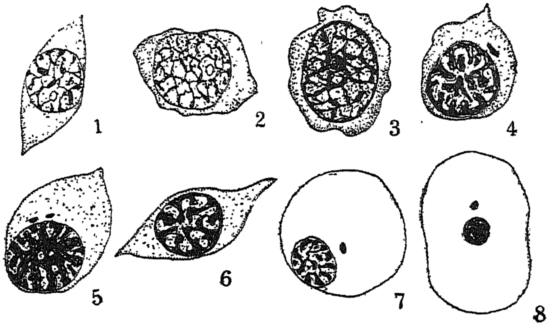

Fig. 5. Various stages of erythrocytopoiesis seen in *Dendrostoma*. ca. ×1100.

The endothelial proliferation is seen only in the peritoneal blood vessels, where the endothelial cells become hypertrophic and are proliferated into vascular lumen (Fig. 4). These cells are usually round or oval, and possess relatively large nuclei filled with sporadically scattered chromatin granules. No mitosis is seen in this locus. Subsequent differentiation is performed in the general circulation, and the mitoses are seen frequently there (Fig. 4, 7–8). It seems to the author that there are, at least, three directions of differentiation of proliferated endothelial cells. The first course (Fig. 5) is the ordinary erythrocytopoiesis which begins with the darkening of nuclear tone. The nuclei of proliferated endothelial cells are stained comparatively pale in colour owing to the sparseness of chromatins. But these chromatin granules become finer and numerous a short time later, and in consequence the nuclei are stained strongly in dark tone. In this stage the nuclei take a sieve-like appearance (Fig. 5, 2–3), similar to those found in the erythroblasts of higher vertebrates. Such sieve-like appearance is, however, not obvious so long. The blocks of chromatins become less angular and in many cases are to be slightly swollen. In this stage the cells are characterized by the hemoglobin formation, resulting in a definite pinkish-staining reaction. The sieve-like appearance of the earlier nuclei turns into the shape of cart-wheel or that of fern-leaf (Fig. 5; 5), and the cytoplasm is stained more polychromatophilically. The further differentiation occuring within the cells is the growth of cytoplasm mass accompanied by elaboration of more hemoglobin. The latter process results in more deeply acidophilically stained cytoplasm. The nucleus becomes smaller, more concentrated, and more deeply stainable (Fig. 5, 7–8). The individual chromatin blocks become less distinct. Thus erythrocytopoiesis is completely finished. The erythrocytes still possessing a large nucleus may increase their number by mitosis.

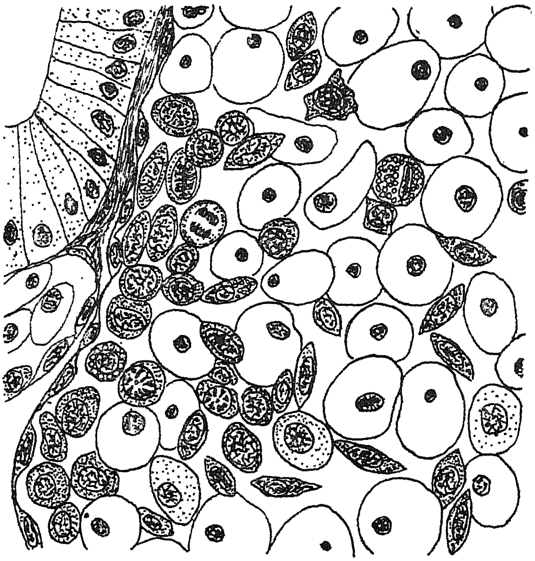

Fig. 6. A part of a large blood vessel in which a number of spindle-shaped microerythroblasts are seen. ca. ×900.

The second differentiation is the formation of spindle-shaped cells. They measure about 10–12 micra in diameter at the longer, and 6–8 micra at the shorter. The nucleus located in the middle of the cell is relatively large and its chromatin blocks are fine and numerous. The cytoplasm is stained deeply basophilically at first, but it becomes eosinophilic through the stage of polychromatophilism. These cells grow into small erythrocytes measuring about 8–12 micra in diameter. The feature seen in nuclear change of these spindle-shaped erythroblasts is similar to that of the ordinary erythroblasts. Cells of this kind are found abundantly in the marginal portion of relatively large blood vessels (Fig. 6).

The third course of differentiation is leucocytopoiesis. The hyaline leucocytes originate from the proliferated endothelial cells. By successive divisions, the cytoplasm of these proliferated cells becomes narrower and narrower, and is stained intensely basophilically. The nucleus is round, oval or more or less indented and its chromatin granules are in the form of a few large angular blocks or of a few coarse and irregularly entangled threads.

The ancestral cells of granulocytes may also originate from the cells on the way of differentiation into hyaline leucocytes. In the early stages of development the nucleus of young granulocyte is very like that of hyaline leucocyte and the cytoplasm contains bluish and reddish granules mixed. The nucleus becomes gradually smaller and smaller in proportion to the increase of granules and frequently takes a flattened shape and is located in an eccentric position. Then the cytoplasm is densely filled with granules and, at last, the nucleus is hidden by them.

By the supravital staining with 0.1 per cent solution of brilliant cresyl blue, the cytoplasmic portion of the erythroblast is densely filled with fine and stained granules (Fig. 7; 1). The number of granules decreases gradually with cytoplasmic differentiation, but the perinuclear region remains still filled up with granules (Fig. 7, 2–4). It seems that these perinuclear granules are scattered again into the cytoplasm and are arranged in a reticular manner (Fig. 7; 5). Such reticulation pattern gradually crumbles in the matured erythrocytes. The fully matured ones which possess pyknotik nuclei have a small number of these granules (Fig. 7; 6).

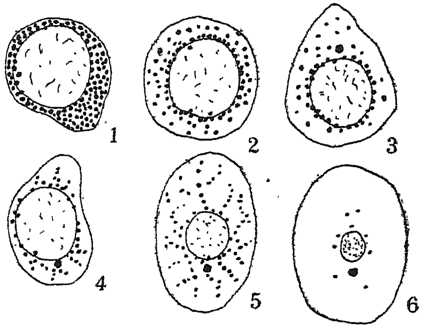

Fig. 7. Successive stages of erythrocyte-maturation. (Supravitally stained with brilliant cresyl blue.) ca. ×1100.

The mesotherial proliferation and the following maturation show a good resembrance to those of *Phoronis* (OHUYE, 1942).

In short the hemopoiesis of the matured *Dendrostoma* is essentially performed in the endothelium, the mesothelium and in circulating blood, and there is no specific organ of blood formation.

The observation done by using the fresh specimens was carried on at the Amakusa Marine Biological Station of the Kyûsyû Imperial University during the summer of 1940. The author wishes to express his hearty thanks to the gentlemen of the staff of that station for their generous

help and valuable suggestion. Thanks are also due to Prof. Dr. S. Hôzawa for his kindness in reading this manuscript in spite of his precious time.

SUMMARY

The erythrocytes of *Lineus fuscoviridis* show a good resembrance to those of the Holothurids, such as *Caudina* and *Molpadia* in structure and in various staining reactions. The so-called rhyncocoelomic corpuscles are nothing but the white blood corpuscles in which four kinds of cells are distinguishable.

The blood corpuscles of *Dendrostoma minor* possess a close resembrance to those of *Physcosoma scolops* except the total absence of " urn ". The hemopoiesis of this animal is essentially performed in the endothelium, mesothelium and in circulating blood, and there is no specific organ of blood formation.

LITERATURE CITED

Bürger, O., 1890. Untersuchungen über die Anatomie und Histologie der Nemertinen, nebst Beiträgen zur Systematik. Z. f. wiss. Zool., Bd. 50, S. 1–277.

—— 1895. Die Nemertinen des Golfes von Neapel. Fauna und Flora des Golfes von Neapel. 22 Monogr. Berlin.

Kawamoto, N., 1927. The anatomy of *Caudina chilensis* with special reference to the perivisceral cavity, the blood and the water vascular system in their relation to the blood circulation. Sci. Rep. Tohoku Imp. Univ., Biol., Vol. 2, pp. 239–264.

Ohuye, T., On the coelomic corpuscles in the body fluid of some invertebrates. IV. On the coelomic corpuscles of a holothurid, *Molpadia roretzii* with reference to those of *Caudina chilensis*. Ibid., Vol. 11, pp. 207–222, 1936. VII. On the formed elements in the body fluid of some marine invertebrates which possess the red blood corpuscles. Ibid., Vol. 12, pp. 203–239, 1937. XI. Supplementary observation on the cytoplasmic inclusions of the red coloured corpuscles in the blood of some marine invertebrates. Ibid., pp. 623–628, 1938.

Riepen, O., 1933. Anatomie und Histologie von *Malacobdella grossa* (Müll.). Z. f. wiss. Zool., Bd. 143, S. 324–496.

STUDIES ON FRESHWATER BRYOZOA OF JAPAN. III
FRESHWATER BRYOZOA OF HOKKAIDŌ

BY

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(With 9 Text-figures)
(Received June 12, 1942)

The fauna of the freshwater Bryozoa of Hokkaidô has remained hitherto entirely unknown to us. The present paper affords the first record on the animals of that group found in Hokkaidô, dealing with the forms which were obtained by the writer during his collecting tour executed in the year of 1940. The species and the varieties identified are shown in the following list.

1. *Paludicella articulata* (EHRENBERG)
2. *Fredericella sultana* (BLUMENBACH)
3. *Plumatella repens* LINNÉ
4. *P. repens* var. *emarginata* (ALLMAN)
5. *P. repens* var. *minuta* TORIUMI
6. *H. repens* var. *fruticosa* (ALLMAN)
7. *Hyalinella punctata* (HANCOCK)
8. *H. toanensis* HÔZAWA & TORIUMI
9. *Stephanella hina* OKA
10. *Cristatella mucedo* CUVIER

Of these forms, *Plumatella repens* var. *minuta*, *P. repens* var. *fruticosa*, *Hyalinella punctata*, *H. toanensis*, *Stephanella hina* and *Cristatella mucedo* are those of which the zoaria were not able to secure everywhere the writer visited, only the statoblasts are obtainable. It seems likely to be the reason that the season was not fitted to collect the former, while of the remaining four forms it was fortunate enough to obtain both of zoaria and statoblasts.

The writer should like to express here his hearty thanks to Professor SANJI HÔZAWA for his kind help.

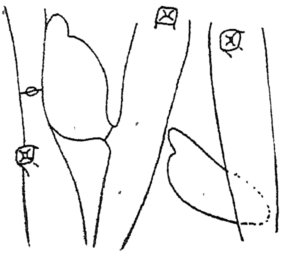
1) Paludicella articulata (Ehrenberg)

Alcyonella articulata, Ehrenberg, 1831.

Paludicella ehrenbergi, Allman, 1856, pp. 113–115, Pl. X, figs. 1–5; Vangel, 1894, p. 153; Davenport, 1904, p. 215, Pl. VI, fig. 3;

Paludicella articulata, Allman, 1844, p. 331; Kraepelin, 1887, pp. 98–99, Pl. IV. fig. 107; Harmer, 1915, pp. 441–447, Pl. LXII, figs. 1–10; Rousselet, 1916, p. 141; Rogick, 1935, pp. 248–249; 1940 p. 194, Pl. I, fig. 4, Pl. II, fig. 5; Toriumi, 1941, p. 195; 1941, pp. 414, Fig. 1.

The branches forming zoarium are rather sparse and are either recumbent or erect. The ectcyst is not encrusted and is in color of a pale brown hue and trnsparent. It was not able to count the number of the tentacles. Only two hibernacula (text-fig. 1) which are somewhat irregularly short spindle shape are present in the wider part of the zooecia. The chitinous wall of the hibernacula is thicker than that of the zooecia, being elastic and yellowish brown in color, and transparent. The species was found in Kabuto-numa near Kabuto-numa Station.



Text-fig. 1. Two hibernacula of *Paludicella articulata*

2) Fredericella sultana (Blumenbach)

Tubularia sultana, Blumenbach, 1779.

Fredericella sultana, Allman, 1844, p. 331; 1856, pp. 110–111, Pl. IX, figs. 1–7; Hancock, 1850, p. 173; Kraepelin, 1887, pp. 103–104, Pl. VII, fig. 138; Vangel, 1894, p. 153; Annandale, 1910, p. 39; Harmer, 1915, pp. 448–449, Pl. LXIII, figs. 11–14; Rogick, 1935, p. 250, Pl. XL, fig. 2; 1937, pp. 101–102, Fig. 1; 1940, p. 195, Pl. III, fig. 13; Toriumi, 1941, pp. 196–197, Fig. 1;. 1941. p. 415, Fig. 2.

The zoarium is recumbent, branching antler-like. The branching is widely opened. The ectocyst is sandy or gray in color, being encrusted. The zooecia are long, very slender, nearly cylindrical and are strongly keeled.

The septum which is pale brown is rarely present at the base of each branch. The number of the tentacles is between 19 and 22. The fixed statoblasts are present. The shape and size of these statoblasts are variable. The fixed statoblasts vary from 0.38 to 0.52 mm in length and from 0.2 to 0.3 mm in breadth. The specimens of this species were secured from Kabuto-numa, Akan-ko and Abasiri-ko.

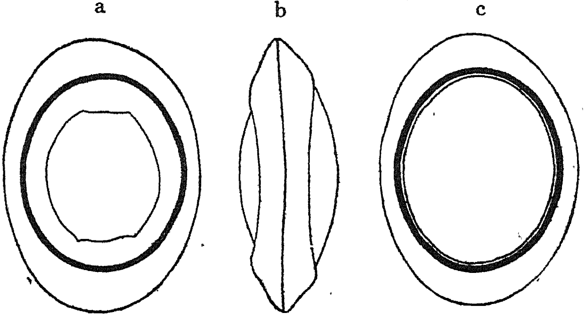
3) Plumatella repens LINNÉ

Tubipora repens, LINNÉ, 1785.
Plumatella repens. ALLMAN. 1856, pp. 93–99, Pl. V, figs. 1–8; VANGEL, 1894, p. 154; ANNANDALE, 1910, pp. 43–44; HARMER, 1913, p. 450, Pl. LXIII, fig, 21.
Plumatella polymorpha var. *repens*. KRAEPELIN, 1887, p. 123, Pl. IV, figs. 119, 122, Pl. VII, fig. 139.
Plumatella repens phase *alpha*, *beta*, ROGICK, 1935, pp. 252–253; 1937, p. 100.
Plumatella repens var. *typica*, phase *beta*, ROGICK, 1940, pp. 201–203, Pl. III, figs. 14, 15, Pl. IV, figs. 20–24.
Plumatella repens var. *typica*, TORIUMI, 1941, pp. 197–198, Fig. 2, Pl. XII, fig. 3.

The zoarium is entirely recumbent, and branches in an antler-like manner.

The ectocyst is not stiff, swollen, colorless and hyaline. The zooecia are entirely recumbent. The number of the tentacles ranges from 49 to 61. The free statoblasts are oval or nearly circular in shape. The annulus covers the capsule a little more on one face (so-called dorsal side) than the other.

The capsule is minutely mammillated. The length of the free statoblasts is between 0.35 and 0.38 mm and the breadth of the same is from 0.25 to 0.28 mm.



Text-fig. 2. Free statoblasts of *Plumatella repens*. ×100. a, dorsal; b, lateral; c, ventral view.

The capsule varies from 0.24 to 0.29 mm in length and from 0.20 to 0.22 mm in breadth. The fixed statoblasts are oval in shape, possessing chitinous lamella which show obscurely an irregular reticulation due to the vestigial air-cells. The length of the capsule is from 0.43 to 0.50 mm and the breadth is from 0.34 to 0.35 mm. The width of the chitinous lamella is about 0.05 mm. The capsule is brown in color, and is minutely mammillated. The species was secured from Akan-ko and Sikaribetu-ko.

4) P. repens var. emarginata (ALLMAN)

Plumatella emarginata, ALLMAN, 1844; 1856, p. 104, Pl. VIII, figs. 5–10; BRAEM, 1890, pp. 9–10, Pl. I, figs. 9, 12, 14; ANNANDALE, 1910, p. 47; VORSTMAN, 1928, p. 4, Figs. 1, 2, Pl. I, figs. 1–4; HASTINGS, 1929, p. 137.

Plumatella princeps var. *emarginata*, KRAEPELIN, 1887, p. 120, Pl. IV, fig. 108, Pl. V, fig. 123.
Plumatella emarginata forma *typica*, LEE, 1939, pp. 401–403, Fig. II.
Plumatella repens var. *emarginata*, VANGEL, 1894, p. 154; ROGICK, 1935, pp. 255–256, Pl. XLI, fig. 6; 1937, pp. 100–101; 1940, pp. 198–200, Pl. I, figs. 1–3, Pl. III, figs. 11, 12; HÔZAWA & TORIUMI, 1940, p. 427, Fig. 2, Pl. fig. 7; TORIUMI, 1941, pp. 199–200, Fig. 3, Pl. XII, figs. 6, 9; 1941, pp. 416–417, Fig. 3.

The zoarium is recumbent, and the branches are antler-like in form.

The ectocyst is encrusted and ranges in color from dark brown to sandy.

The zooecia are long, nearly cylindrical, and are keeled. The septa are crescent-shaped and are of a deep brown or black color. The number of the tentacles varies from 34 to 42. The free statoblasts are elongate and are sometimes oval, being either rounded or subtruncated at both ends. The annulus covers the greater part of the one face, and a small part of the other of the capsule. Usually the annulus is distinctly narrower on both sides than at the ends. The free statoblasts are 0.32–0.40 mm in length, and 0.19–0.24 mm in breadth. The length of the capsule is between 0.23 and 0.27 mm and its breadth is between 0.17 and 0.20 mm. The fixed statoblasts are present. The capsule of the fixed statoblasts is 0.37–0.43 mm long and 0.25–0.30 mm wide. The chitinous lamella of the fixed statoblasts is about 0.02 mm in width and is minutely serrated on the margin.

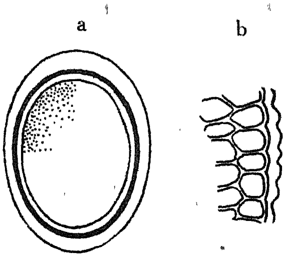
This variety was obtained from Ko-numa at Wakkanai-mati and Kabuto-numa.

5) P. repens var. minuta TORIUMI

Plumatella repens var. *minuta*, TORIUMI, 1941, pp. 202–203, Fig. 6, Pl. XII, figs. 7, 8; 1941, p. 417, Fig. 4.

Only the free statoblasts (text-fig. 3) were secured from Tôya-ko.

They are oval and are about 0.265 mm long and 0.19–0.195 mm wide. The capsule of the same varies from 0.21 to 0.22 mm in length and from 0.16 to 0.17 mm in breadth. The margin of the annulus bears a number of irregular minute processes (text-fig. 3, b) and they are visible when strongly magnified. The capsule is mammillated.

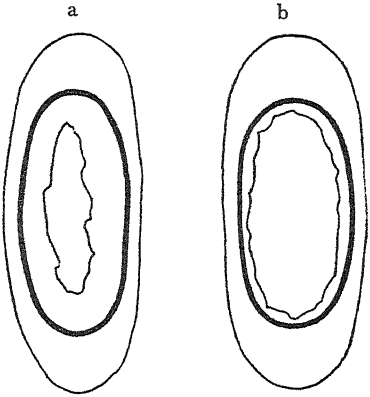


Text-fig. 3. Free statoblast of *P. repens* var. *minuta*. a, entire specimen ×100 b, serration on the margin of the annulus ×500

6) P. repens var. fruticosa (ALLMAN)

Plumatella fruticosa, ALLMAN, 1844; 1856, p. 102, Pl. VI, figs. 3–5; ANNANDALE, 1910, p. 45; HARMER, 1913, p. 453;
Plumatella lucifuga, JULLIEN, 1885.
Plumatella princeps var. *fruticosa*, KRAEPELIN, 1887, p. 120, Pl. VII, fig. 148;
Plumatella repens var. *fruticosa*, ROGICK, 1935, p. 255; TORIUMI, 1941, pp. 200–202, Figs. 4. 5, Pl XIII, fig. 17.

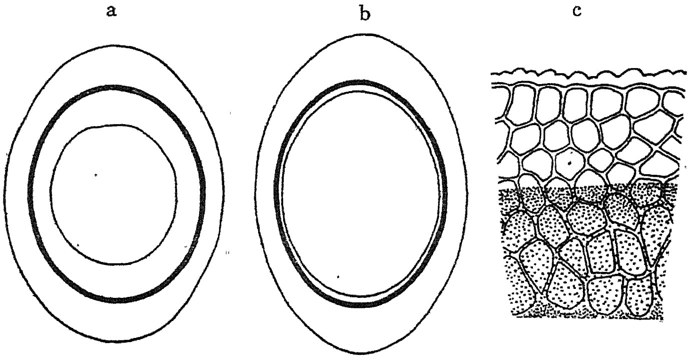
Only the free statoblasts (text-fig. 4) were collected. The free statoblasts are elongate and vary from 0.41 to 0.48 mm in length and from 0.17 to 0.20 mm in breadth. The capsule of the same is between 0.22 and 0.27 mm in length and the breadth is from 0.15 to 0.17 mm. The free statoblasts were secured from a small pond near Tomakomai Station, Sikaribetu-ko and Ô-numa.



Text-fig. 4. Free statoblasts of *P. repens* var. *fruticosa*. a, dorsal; b, ventral view ×100

7) Hyalinella punctata (HANCOCK)

Plumatella punctata, HANCOCK, 1850, p. 200, Pl. V, figs. 6–7, Pl. VI, fig. 1; ALLMAN, 1856, pp. 100–102, Fig, 15; ANNANDALE, 1910, p. 52; 1919, p. 94;
Plumatella vesicularis, JULLIEN, 1885; VANGEL, 1894, p. 155.
Hyalinella punctata, ROGICK, 1935, p. 251; 1940, pp. 196–198, Pl. II, figs. 6–10, Pl. V, fig. 25; TORIUMI, 1941, pp. 204–205, Fig. 8, Pl. XII, fig. 2, Pl. XIII, fig. 12: 1941, p. 420, Fig. 8.



Text-fig. 5. Free statoblasts of *Hyalinella puuctata*. a, dorsal; b, ventral view ×100 c, serration on the margin of the annulus ×500

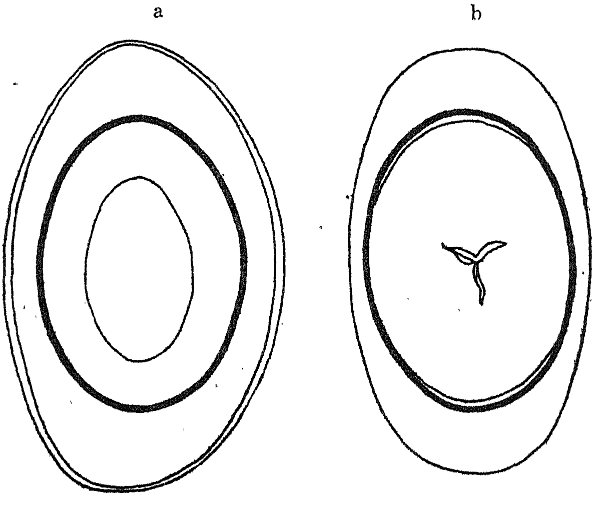
The free statoblasts (text-fig. 5) are oval or nearly circular in shape and vary from 0.36 to 0.41 mm in length and from 0.27 to 0.29 mm in width. The capsule of the same is measured 0.26–0.30 mm long and 0.21–0.23 mm wide.

The margin of the annulus bears a number of irregular minute processes (text-fig. 5, C). The free statoblasts of this species were found in Ô-numa.

8) **H. toanensis** Hôzawa & Toriumi

Hyalinella toanensis, Hôzawa & Toriumi, 1940, Fig. 6, Pl. fig. 4, pp. 431–432; Toriumi, 1941, p. 205, Fig. 9, Pl. XII. fig. 1, Pl. XIII, fig. 11; 1941, pp. 421–422, Figs. 9, 10.

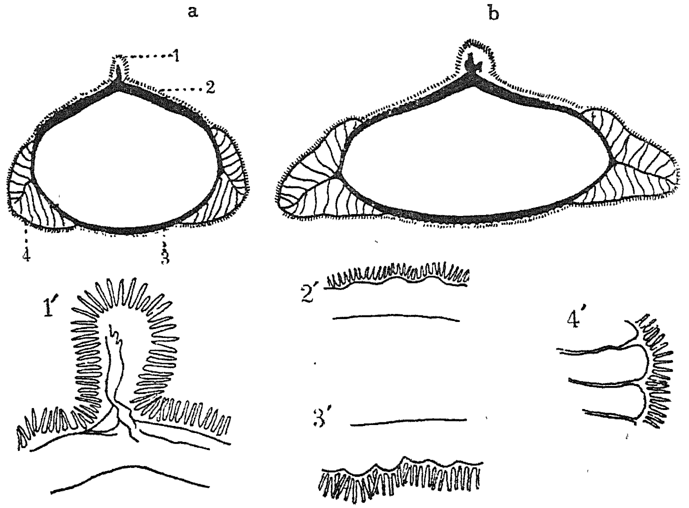
The free statoblasts (text-fig. 6) are elongated with both ends rounded. The annulus covers a little more on one face than the other. The capsule has a large blunt process in the center of one face (so-called ventral side). The blunt process above mentioned is provided with a peculiarly formed appendage which is spinous and pale brown in color and is transparent. Some statoblasts are covered with very minute spines on the whole surface.



Text-fig. 6. Free statoblasts of *H. toanensis.* ×100 a, dorsal; b, ventral view.

These spines are always seen in fresh free statoblasts, but when the statoblasts become old and when finished the germination these are worn out.

In Japanese specimens the minute spines are very long in proportion to the length of the statoblast (text-fig. 7), while in the Manchoukuo specimen they are very short on account of their young stage. These spines are visible very clearly in cross or saggital section of the free statoblast. The fixed statoblasts are destitute of these spines. The length of the free statoblasts varies from 0.48 to 0.55 mm and the breadth ranges from 0.30 to 0.35 mm. The capsule is measured between 0.34 and 0.38 mm in length and is from 0.26 to 0.28 mm in breadth.



Text-fig. 7. a, Cross b, saggital sections through the free statoblasts of *H. toanensis* showing the minute spines on the surface. These statoblasts were collected from a small pond in Sendai City in 1941. ×100 1′–4′ enlarged view of each portion of 1–4 ×500

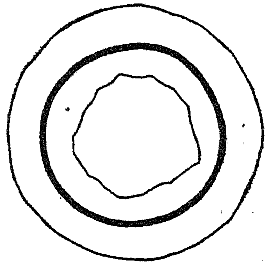
The free statoblasts were secured from Ô-numa.

9) Stephanella hina Oka

Stephanella hina, Oka, 1908, pp. 277–285, Pl. X, figs. 1–5; Toriumi, 1941, p. 207, Fig. 10; 1941, p. 422, Fig. 11.

The free statoblasts (text-fig. 8) are circular in shape and vary from 0.32 to 0.37 mm in diameter. The capsule ranges from 0.22 to 0.25 mm in diameter.

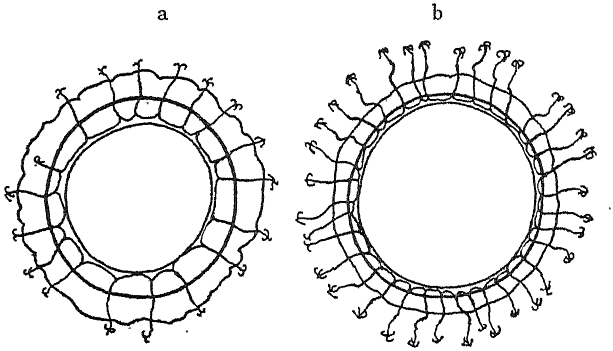
They were found in Ô-numa and Tôya-ko.



Text-fig. 8. Free statoblast of *Staphanella hina*. ×100

10) Cristatella mucedo CUVIER

Cristatella mucedo, CUVIER, 1798; ALLMAN, 1856, pp. 77–80, Pl. I, figs. 1–8; HÔZAWA, 1939, p. 104; TORIUMI, 1941, pp. 211–213, Fig. 15, Pl. XIII, fig. 16.



Text-fig. 9. Two statoblasts of *Cristatella mucedo*. ×40

The statoblasts of this species were collected from Ô-numa, Sikaribetuko and Kabuto-numa. They are 0.72–0.80 mm in diameter.

The capsule is 0.58–0.66 mm in diameter. Only two statoblasts were found to retain their spines on one face (text-fig. 9, a, b).

LITERATURE CITED

ALLMAN, G. J., 1844. Synopsis of the Genera and Species of Zoophytes inhabiting the Fresh Waters of Ireland. Ann. Mag. Nat. Hist. I: 13, pp. 328–331. 1856, Monograph of Fresh-water Polyzoa. Ray Soc. London.

ANNANDALE, N., 1910. Materials for a Revision of the Phylactolaematous Polyzoa of India. Rec. Ind. Mus. Vol. 5, pp, 37–57.

HANCOCK, A., 1850. On the Anatomy of the Freshwater Bryozoa, with Descriptions of three Species. Ann. Mag. Nat. Hist. II: 5, pp. 173–204.

HARMER, S. F., 1913. The Polyzoa of Waterworks. Proc. Zool. Soc. London. 1913, pp. 426–457.

HÔZAWA, S., 1939. *Cristatella mucedo* CUVIER found in Japan. A Report which was made at the 14th Annual Meeting of the Zoological Society of Japan of 1938 and which was published in the Zoological Magazine Vol. 51, No. 2, p. 104.

HÔZAWA, S. & TORIUMI, M., 1941. Some Freshwater Bryozoa found in Manchoukuo. Sci. Rep. Tôhoku Imp. Univ. Ser. 4, Vol. 16, No. 3, pp. 233–241.

JULLIEN, J., 1885. Monographie des Bryozoaires d'Eau Douce. Bull. Soc. Zool. de France, X, 119 pp.

KRAEPELIN, K., 1887. Die Deutschen Süsswasser-Bryozoen. Abh. Naturwiss. Hamburg.

LEE, L., 1936. Notes on some Fresh-water Polyzoa of Peiping. Sinensia, Vol. 7, pp. 399–407.

MIYAJI, D., 1934. On the Statoblasts of Fresh-water Polyzoa, *Cristatella*, found in South

Saghalin. (Karahuto nite Hakken sitaru Tansui-Kokemusi *Cristatella* no Kyuga.) Botany and Zoology, Vol. 3, No. 5, p. 125.

OKA, A., 1907. Zur Kenntnis der Süsswasser-Bryozoenfauna von Japan. Annot. Zool. Japan, Vol VI, pp. 117–123.

——, 1908. Über eine neue Gattung von Süsswasserbryozoen (Stephanella n. g.). Ibid. pp. 277–284.

POTTS, E., 1884. On a supposed New Species of *Cristatella*. Proc. Acad. Nat. Sci. Philadelphia. 1884, pp. 193–199.

ROGICK, M. D., 1935. Studies on Freshwater Bryozoa. II, The Bryozoa of Lake Erie. Trans. Amer. Micro. Soc. Vol. LIIII, No. 3, pp. 245–253. 1940, IX. Additions to New York Bryozoa. Ibid. Vol. LIX, No. 2, pp. 187–204.

TORIUMI, M., 1941. Studies on Freshwater Bryozoa of Japan I. Sci. Rep. Tôhoku Imp. Univ. Ser. IV, Vol. XVI, No. 2. pp. 193–215.

——, 1941. II. Freshwater Bryozoa of Tyosen (Korea) Ibid. Vol. XVI, No. 4, pp. 413–425.

VANGEL, E., 1894. Daten zur Bryozoen, Fauna Ungarns. Zool. Anz. 17, pp. 153–155.

VORSTMAN, A., 1928. Some Fresh-water Bryozoa at West Java. Treubia, Vol. 10, pp. 1–14.

STUDIES ON FRESHWATER BRYOZOA OF JAPAN. IV
FRESHWATER BRYOZOA OF TAIWAN (FORMOSA)

BY

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(With 3 Text-figures)

(Received June 26, 1942)

The present report deals with the materials obtained from Taiwan by Mr. N. SASAKI in 1936 and by the present writer in 1941.

The forms determined are shown in the following list.

1. *Fredericella sultana* (BLUMENBACH)
2. *Plumatella repens* var. *emarginata* (ALLMAN)
3. *P. repens* var. *casmiana* (OKA)
4. *P. repens* var. *minuta* TORIUMI
5. *Hyalinella punctata* (HANCOCK)
6. *H. toanensis* HÔZAWA & TORIUMI
7. *Pectinatella gelatinosa* OKA
8. *Lophopodella carteri* (HYATT)

The writer expresses his hearty thanks to Professor SANJI HÔZAWA for the kind supervision given by him during the course of the present study.

The writer is also obliged to Mr. NOBUO SASAKI for his kindness and generosity in giving to the writer, many valuable specimens which he collected in Taiwan. Thanks are also due to the Japan Society for the Promotion of Scientific Research for the financial support by means of which the present study was made.

1) Fredericella sultana (BLUMENBACH)

Tubularia sultana, Blumenbach, 1779.

Fredericella sultana, ALLMAN, 1856, pp. 110–111, Pl. IX, figs. 1–7; HANCOCK, 1850, p. 173; KRAEPELIN, 1887, pp. 103–104, Pl. VIII, fig. 138; BRAEM, 1890, pp. 1–13, Pl. 1, fig. 11; ANNANDALE, 1910, p. 39; ROGICK, 1935, p. 250, Pl. XL, fig. 2; 1937, pp. 101–102, Fig. 1; 1940, p. 195, Pl. III, fig. 13; TORIUMI, 1941, p. 196; 1941, p. 415.

The zoarium is recumbent and sparingly branched. The ectocyst is encrusted and ranges in color from yellowish brown to sandy. The zooecia are long, slender and keeled. The polypides are degenerated except in a few specimens where the tentacles are between 21 and 24 in number.

Fixed statoblasts are present.

Distribution. A small pond in Taihoku-si; a small pond at Mokusaku near Taihoku-si; a small pond near Tiureki Station; a small pond in Sintiku-si.

2) **Plumatella repens** var. **emarginata** (ALLMAN)

Plumatella emarginata, ALLMAN, 1844; 1856, p. 104, Pl. VII, figs. 5–10; ANNANDALE, 1910, p. 47; VORSTMAN, 1928, pp. 4–5, Fgs. 1, 2, Pl. I, figs. 1–4.

Alcyonella benedeni, ALLMAN, 1856.

Plumatella princeps var. *emarginata*, KRAEPELIN, 1887, p. 120, Pl. IV, fig. 108, Pl. V, fig. 123.

Plumatella princeps var. *muscosa, spongiosa*, KRAEPELIN, 1887, p. 120, p. 121.

Plumatella repens var. *emarginata*, ROGICK. 1935, pp. 255–256, Pl. XLI, fig. 6; 1937, pp. 100–101: 1940, p. 198, Pl. I, figs. 1–3, Pl. III, figs. 11, 12; TORIUMI, 1941, p. 198, Fig. 3; 1941, p. 416, Fig, 3; HÔZAWA & TORIUMI, 1941. p. 235, Fig. 2.

The zoarium is recumbent, branching in antler-like manner. Sometimes the branches are set closely together giving a rugged or a fungoid appearance to the zoarium. Sometimes several, free, short branches are sent off from the zoarium. The ectocyst is blackish brown, yellowish brown, sand colored in various shades. The zooecia are keeled and emarginated.

Septa are present. They are incomplete, crescentic in shape and deep brown or black in color. The length of the free statoblasts is 0.33–0.48 mm and the breadth is 0.20–0.26 mm. The capsule is 0.21–0.30 mm long and 0.16–0.21 mm wide.

Distribution. Binrôtan near Kôsyun-gai; a small pond in Takao-si; Rentihi near Takao-si; a small pond near Syaroken Station; a small pond in Tainan-si; two small ponds near Bansiden Station; Bansikyôhi near Bansiden Station; a small pond near Rinhôei Station; Sekizanbyô-no-ike near Rinhôei Station; a small pond at Rokko-gai near Rinhôei Station; Benten-ike near Tôen Station; a small pond at Tyûreki-gai; three small ponds in Taihoku-si; three small ponds at Mokusaku near Keibi Station; a small pond near Matuyama Station; two small ponds at Naiko in Taihoku-si; a small pond at Hatirisyô near Tansui-gai; a small pond in Tansui-gai; two small ponds near Hokuto Station; a small pond near Tôi Station; Taiampi at Ratô-gai.

3) P. repens var. casmiana (OKA)

Plumatella casmiana, OKA, 1907, p. 317, Fig. 3; VORSTMAN, 1928, p. Fig. 1, Fig. 5, Pl. I, fig. 8; ROGICK, 1941, pp. 211–214, Pl. I, figs. 1–4, Pl. II, Figs. 5, 6.

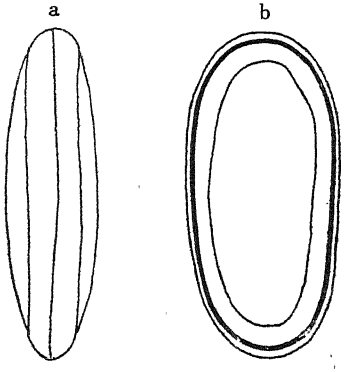
Plumatella repens var. *casmiana*, TORIUMI, 1941, pp. 203–204, Fig. 7, Pl. XII, figs. 4, 5, Pl. XIII, fig. 15.

Plumatella repens var. *flabellum*, ROGICK, 1934, p. 317; 1935, p. 245; 1937, p. 99; TORIUMI, 1941, pp. 418–419, Figs. 5–7.

The writer called this form *P. repens* var. *flabellum* in his former report on the Korean Bryozoa and alluded to the fact that it produces free statoblasts of two kinds (1941, B, p. 419). When he made a collection of Bryozoa in the Kantô and Tôhoku districts of Japan during 1938 and 1939 he obtained some specimens of this form.

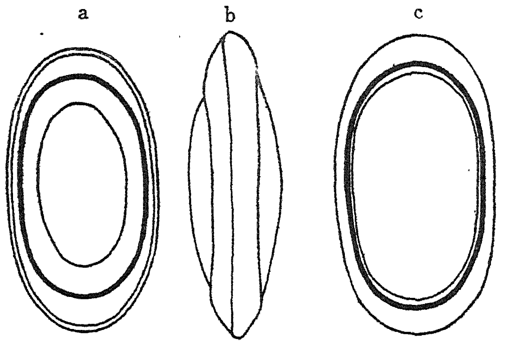
At that time, he was unable to identify one of the forms of the present variety namely that producing free statoblasts of type *b* (provisionally named type *typica* in 1941, B, p. 419). Until the writer examined the specimen of *P. repens* var. *flabellum* which Dr. M. D. ROGICK kindly sent to him in 1940, he had not noticed that the Japanese form in question agrees very closely with the variety above mentioned and that the statoblasts of different types are in some rare cases produced in the same zoarium.

Examining the American specimen of *P. repens* var. *flabellum* it was found that one zoarium was attached to its base by two valves of a statoblast belonging to the *a* type (provisionally named type *casmiana* in 1941, B), and that it was producing a newly formed free statoblast of another type *b*. Taking note of the above mentioned fact the writer examined once more Japanese specimens of *casmiana* and the form in question, and thus it was ascertained that these two forms are to be included in one variety, and that this variety produces two kinds of free statoblasts.

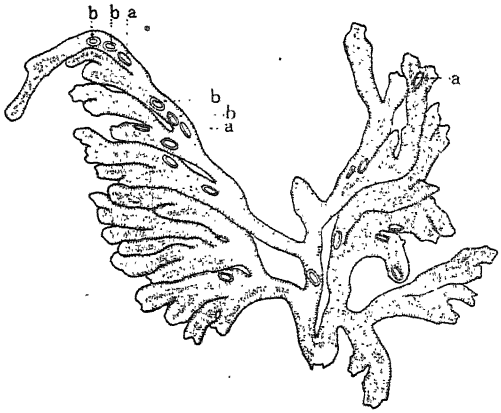


Text-fig. 1. Free statoblasts of *Plumatella repens* var. *casmiana*. *a* type statoblasts. ×100

The zoaria possessing statoblasts of *a* type or *b* type respectively are alike in their external appearance, but owing to the fact that the two kinds of free statoblasts of these zoaria show conspicuously different features, it is doubtful whether these two forms belong to one variety.



Text-fig. 2. Free statoblasts of *P. repens* var. *casmiana*. *b* type statoblasts. ×100



Text-fig. 3. Zoarium of *P. repens* var. *casmiana* showing two kinds of free statoblast. a --- *a* type statoblasts b --- *b* types tatoblasts. This zoarium was obtained from Tyôsen in 1938 by N. SASAKI. (Freehand sketch.)

If there were found two kinds of statoblasts in one zoarium at the same time, then these two forms might be included in one variety.

This point will be solved by the following fact. When many specimens of this variety are examined carefully, it is always noticed that some zoaria possess these two kinds of free statoblasts in the same branch.

In the Japanese specimen it was found that the zoaria of the present variety produce two kinds of free statoblasts in one short branch, sometimes in one zooecium.

In the specimens from Taiwan, the zoaria of this variety were found entirely recumbent branching densely. The zoarium appears flabelliform in most cases and sometimes is geminated. The branches are in some rare cases very widely open. The number of tentacles varies from 25 to 36.

Among the the eight specimens of this variety, four were noticed to possess two kinds of statoblasts in one zoarium at the same time. Usually these statoblasts of different types are produced in different parts of the same zoarium, namely one in the old part and the other in the new part, or one in the right part and the other in the left part of the zoarium.

But sometimes they are produced in one short branch, and sometimes in one zooecium at the same time.

In one zoarium which originated from the *b* type of free statoblast, it was seen that the *a* type of free statoblast was newly produced.

The ectocyst is encrusted. The color of the ectocyst is yellowish brown, sandy and gray–usually gray–and is opaque. Sometimes in the distal part of the zooecium, the ectocyst is pigmented with a dark gray color.

The keel is present. In some well developed zoaria producing the *b* type of free statoblasts a fine geminate form was observed.

Sometimes these statoblasts are produced even in the zoarium which is very small as ALLMAN has shown on Pl. IV. fig. 3 of his Monograph.

The fact just mentioned as well as the fact that the statoblast is in some rare cases slightly broader (Toriumi, 1941, B, p. 418, Fig. 6, d) may suggest the possible existence of *flabellum*. Unless, however, VAN BENEDEN'S *Alcyonella flabellum* specimen be reexamined, it cannot be ascertained whether *flabellum* exists or not.

In Taiwan the two types of free statoblasts alluded to above were found in one pond at the same time.

The length of the *a* type statoblasts is between 0.35 and 0.46 mm, and the breadth is between 0.17 and 0.24 mm.

The length of the *b* type statoblasts is between 0.32 and 0.37 mm, and the breadth is 0.19 and 0.21 mm. The capsule is 0.26–0.30 mm long and 0.16–0.18 mm wide.

The fixed statoblasts possess features similar to those of *P. repens* var. *emarginata*.

Distribution. A small pond in Takao-si; a small pond near Siaroken Station; a small pond and Bansikyôhi near Bansiden Station; a small pond near Hokuto Station; a small pand in Karenkô-gai; a small pond near Tôi Station; Taiampi near Giran Station.

4) P. repens var. minuta TORIUMI

Plumatella repens var. *minuta*, TORIUMI, 1941, p. 202, Fig. 6, Pl. XII, figs. 7, 8; 1941, p. 417, Fig. 4.

Of this variety, only the free statoblasts were secured.

Distribution. Bansikyôhi; a small pond near Siaroken Station; Benten-ike near Tôen Station; a small pond near Matuyama Station.

5) Hyalinella punctata (HANCOCK)

Hyalinella punctata, HANCOCK, 1850, p. 200, Pl. V, figs. 6, 7, Pl. VI, fig. 1; ALLMAN, 1856, pp. 100–102, Fig. 15; ANNANDALE, 1910, p. 52.

Plumatella vesicularis, BRAEM, 1890.

Hyalinella punctata, ROGICK, 1935, p. 251; 1940, pp. 196-193, Pl. II, figs. 6-10, Pl V, fig. 25; TORIUMI, 1941, p. 208, Fig. 8, Pl. XII, fig. 2, Pl. XIII, fig. 12; 1941, p. 420, Fig. 8.

The zoarium forms a flat layer. The ectocyst is hyaline and very thick, being swollen. The polypides are degenerated.

The whole length of the free statoblasts is from 0.46 to 0.50 mm and the breadth is from 0.31 to 0.34 mm. The capsule is from 0.31 to 0.33 mm long and from 0.24 to 0.25 mm wide. Irregular minute serration is seen on the margin of the annulus.

Distribution. A small pond at Hatirisyô near Tansui-gai; two small ponds in Taihoku-si where only the free statoblasts were obtained; two small ponds near Tyûreki Station where only the free statoblasts were secured; a small pond near Keibi Station.

6) **H. toanensis** HÔZAWA & TORIUMI

Hyalinella, toanensis, HÔZAWA & TORIUMI, 1940; 1941, p. 239, Fig. 7; TORIUMI, 1941, p. 205, Fig. 9, Pl. XII, fig. 1, Pl. XIII, fig. 11; 1941, pp. 421-422. Figs. 9, 10.

The free statoblasts only were collected. The minute spines which are to be found on the free statoblasts were worn out because the specimens were rather old.

Distribution. A small pond at Mokusaku near Keibi Station; a small pond near Tyûreki Station.

7) **Pectinatella gelatinosa** OKA

Pectinatella gelatinosa, OKA, 1890; 1907, p. 716, p. 117; ANNANDALE, 1910, p. 56; TORIUMI, 1941, pp. 208–209, Fig. 11, Pl. XIII, fig. 10; 1941, pp. 422–423, Fig. 12.

Pectinatella burmanica, ANNANDALE, 1910, p. 56; VORSTMAN, p. 12, Fig. 9, Pl. I, fig. 12.

Only the free statoblasts were obtained in two small ponds in Taihoku-si. They are mostly circular but in some rare cases are somewhat rectangular and are dark brown in color.

Distribution. Two small ponds in Taihoku-si.

8) **Lophopodella carteri** (HYATT)

Lophopus sp., CARTER, 1859, p. 331.

Lophopodella carteri, ROUSSELET, 1907; VORSTAMAN, 1928, pp. 10–12, Fig. 8, Pl. III, fig. 11; TAKAHASI, 1934, pp. 347-350; TORIUMI, 1941, p. 209, Figs. 12, 13, Pl. XIII, fig. 13; 1941, pp. 423–424, Fig. 13.

Lophopodella carteri var. *typica*, ROGICK, 1934, pp. 416–424; 1935, p. 250.

Lophopodella carteri var. *davenporti*, ROGICK, 1934, p. 420.

Pectinatella davenporti, OKA, 1907, pp. 117–120, Figs. 1, 2.

The number of tentacles ranges from 75 to 82. The free statoblasts are sometimes spindle-shaped and sometimes are more or less elliptical.

They are 1.0–1.1 mm long excluding the spines, and 0.75–0.80 mm wide.

The capsule is 0.48–0.53 mm long and 0.42–0.50 mm wide. The length of the spines is about 0.1 mm (maximum 0.12 mm).

The number of the spines is 7–20 (usually 9–14). Each of these spines bears 1–7 (usually 2–4) barbs on each side.

The annulus has an irregular minute serration on each side.

Distribution. Two small ponds near Tyûreki Station; a small pond at Hatrisyô near Tansui-gai.

LITERATURE CITED

ALLMAN, G J., 1856. Monograph of Fresh-water Polyzoa.

ANNANDALE, N., 1910. Materials for a revision of the Phylactolaematous Polyzoa of India. Rec. Ind. Mus. Vol. 5, pp. 37–57.

BORG, F., 1936. Über die Süsswasser Bryozoen Africas. Senkenbergiana Band, 18, pp. 20–36.

BRAEM, F., 1890. Untersuchungen über die Bryozoen des süssen Wassers. Bibliotheca Zoologica. Heft VI.

CARTER, H. J., 1859. On the Identity in Structure and Composition of the so-called seed-like Body of Spongilla with the Winter Egg of the Bryozoa. Ann. Mag. Nat. Hist. II, 3, pp. 331–343.

HANCOCK, A., 1850. On the Anatomy of the Freshwater Bryozoa, with Description of three Species. Ann. Mag. Nat. Hist. II, 5, pp. 173–204.

HÔZAWA, S. & TORIUMI, M., 1941. Some Freshwater Bryozoa found in Manchoukuo. Sci. Rep. Tôhoku. Imp. Univ. Ser. 4, Vol. 16, No. 3, pp. 233–241.

KRAEPELIN, K., 1887. Die Deutschen Süsswasser-Bryozoen. Abh. Naturwiss. Hamburg.

OKA, A., 1891. Observations on Fresh-water Polyzoa (*Pectinatella gelatinosa*, nov. sp.) Journ. Coll. Sci. Tôkyo Imp. Univ. Vol. IV. Part I. pp. 89–150.

——, 1906. A new Species of Fresh-water Bryozoa. (*Pectinatella davenporti*) Zool. Mag. Tokyo, Vol. 18, pp. 307–310.

——, 1907. Zur Kenntnis der Süsswasser-Bryozoenfauna von Japan. Annot. Zool. Japan, Vol. XI, pp. 117–123.

ROGICK, M. D., 1934. Studies on Freshwater Bryozoa. I. The Occurrence of *Lophopodella carteri* (HYATT) 1886 in North America. Trans. Amer. Micr. Soc. Vol. LII, No. 4, pp. 416–424.

——, 1935. II, The Bryozoa of Lake Erie. Ibid. Vol. LIV, No. 3, pp. 245–263.

——, 1937 V. Some Addition to Canadian Fauna, Ohio Journ. Sci. Vol. XXXVII, No. 2, pp. 99–104.

——, 1940. IX. Additions to New York Bryozoa. Trans. Amer. Micro. Soc. Vol. LIX, No. 2, pp. 187–204.

——, 1941. X. The Occurrence of *Pectinatella casmiana* in North America. Ibid. Vol. LX. No. 2, pp. 211–220.

TAKAHASI, S., 1934. Sur *Lophopodella carteri* (HYATT) d'eau douce, originrire de Formosa. Annot. Zool. Japan. Vol. 14, No. 3, pp. 347–350.

TORIUMI, M., 1941. Studies on Freshwater Bryozoa of Japan. I. Sci. Rep. Tôhoku. Imp. Univ. Ser. 4, Vol. XVI, No. 2, pp. 193–215.

——, 1941. II. Freshwater Bryozoa of Tyosen. Ibid. Vol. XVI, No. 4, pp. 413–425.

VORSTMAN, A. G., 1928, Some Fresh-water Bryozoa at West Java. Treubia, Vol. 10, pp. 1–14.

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CONTENTS

Senji Tanita
Report on the Calcareous Sponges obtained by the Zoological Institute and Museum of Hamburg........ 105

Masayuki Nagao
Studies on the Growth Hormones of Plants. V. Polar Rootlet Formation on Root Segments cultured under Sterile Conditions... 137

Mutsuo Katô
On the Nectar-Cropping Activity of an Andrenid *Halictus Katoi* (in Lit.), Widely distributed at Mt. Hakkôda........ 159

Toshio Ohuye
On the Blood Corpuscles and the Blood Formation in *Phoronis*... 167

Toshio Ohuye
On the Blood Corpuscles and Hemopoiesis of a Nemertean, *Lineus fuscoviridis*, and of a Sipunculus, *Dendrostoma minor*........ 187

Makoto Toriumi
Studies on Freshwater Bryozoa of Japan. III. Freshwater Bryozoa of Hokkaidô........ 197

Makoto Toriumi
Studies on Freshwater Bryozoa of Japan. IV. Freshwater Bryozoa of Taiwan (Formosa)........ 207

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EMBRYOLOGICAL OBSERVATIONS ON *KETELEERIA DAVIDIANA* BEISSNER VAR. *FORMOSANA* HAYATA

BY

YOSINORI SUGIHARA

Biological Institute, Tôhoku Imperial University, Sendai

(With Plates VIII–X and 3 Text-figures)

(Received July 13, 1942)

Keteleeria, a genus of the family *Abietaceae*, is found only in Eastern Asia. The species used in this study, *K. Davidiana* BEISSNER var. *formosana* HAYATA, is distributed in Formosa and China. As far as the writer is aware, our present knowledge concerning the embryogeny of *Keteleeria* is very poor. In 1917, HUTCHINSON published a paper on *K. Fortunei* CARRIEÈRE. In the paper, he described the pollen grains, the male and female cones, the megaspore mother cell, the embryo with cotyledons and the vascular structures.

In 1940 and 1941 the present writer collected material from the trees cultivated in the Taihoku Botanic Garden. The methods used in this study are the same as those which the writer adopted in the previous investigations (SUGIHARA, '41, '41). The observation as to the suspensor formation was carried out in the Botanic Institute of Taihoku Imperial University, using fresh materials.

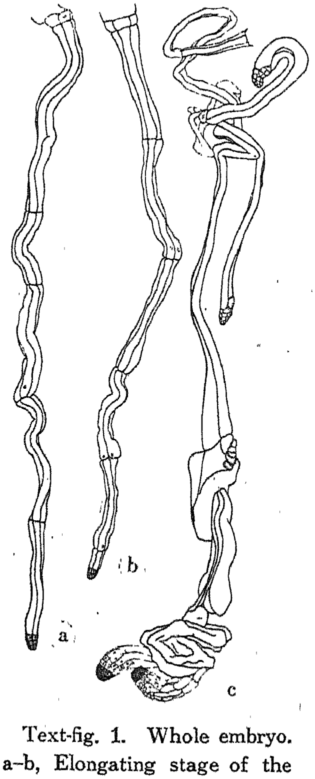
In the male gametophyte of *Keteleeria*, a mitosis of the body cell takes place immediately before the fertilization, to form two sperm nuclei which are different in size (Pl. IX, figs. 15–16). The general structure of the archegonium of *Keteleeria* agrees with that of the other members of *Abietaceae* and *Pinaceae*. The archegonial initials originate in the surface of the female gametophyte. They become larger and larger and each of them cuts off a primary neck cell in its upper extremity. The primary neck cell then divides repeatedly to form sixteen neck cells which are arranged in four rows, each of them consisting of four cells. But variations in the number of the neck cells are sometimes found. The nucleus of the central cell lies at first immediately below the primary neck cell, gradually increases in size and then cuts off a ventral canal nucleus just below the neck cells. Between the ventral canal nucleus and the egg nucleus, the cell wall is formed. That is, the ventral canal cell is formed with the cell walls in all sides. The ventral canal cell does not grow larger, but its nucleus occupies almost the whole space of the cell. The ventral canal cell persists up to about the time of fertilization or still later. Somotimes it is found that in the archegonium in which fertilization did not occur, the cell wall between the ventral canal cell and the egg cell breaks down and the ventral canal nucleus enters into the egg cytoplasm. The ventral canal nucleus grows larger in this condition. The fusion of this nucleus with the egg nucleus was not, however, observed. The egg nucleus at maturity lies slightly upper, above the centre of the cell. In the egg cytoplasm, a multitude of proteid vaculoes are found. The number of archegonia in a female gametophyte is from five to ten, seven being the most common, as shown in the following table.

Number of archegonia in a female gametophyte	5	6	7	8	9	10	total
Frequency	2	16	27	22	5	4	76

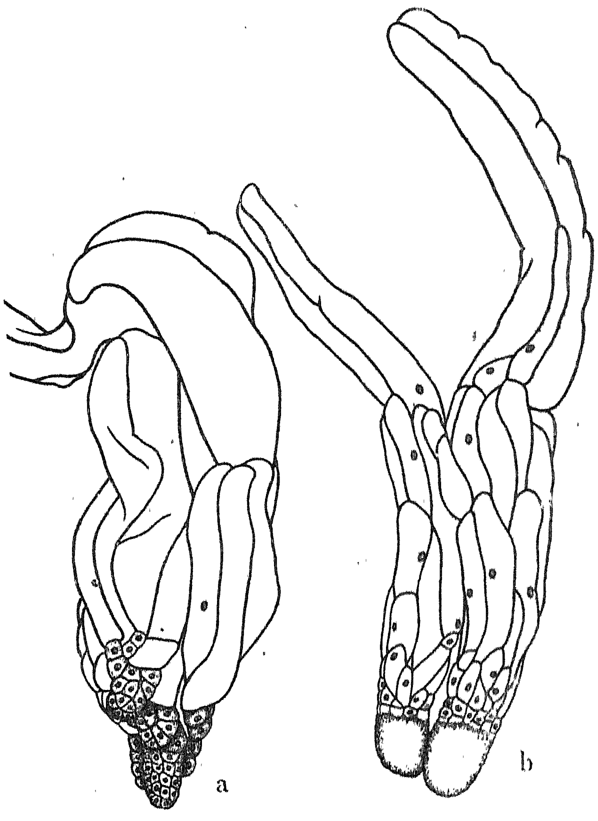
In a transverse section of the apical part of the female gametophyte, the archegonia are found in a circle with a sterile tissue at the centre. Each archegonium has a jacket layer of one cell thick; a common jacket layer surrounding the group of archegonia has not been observed. Each archegonium has an archegonial chamber of its own, a common archegonial chamber not being formed. The size of the archegonium is very large, being visible to the naked eye.

In 1940 and 1941 the fertilization was carried out about 10th of June in Taihoku. By the growth of the pollen tube the neck cells become crushed, but in most cases the ventral canal cell is not destroyed. The pollen tube grows down beside the ventral canal cell. The apex of the pollen tube penetrates into the egg cell for a considerable distance (Pl. VIII, fig. 1). The male nucleus is much smaller than the female nucleus. The male nucleus in contact with the egg nucleus appears at first as if it were a knob of the female nucleus. The male nucleus gradually enters into the female nucleus and assumes for a time the shape of a small spindle (Pl. VIII, fig. 2). A second male nucleus from the pollen tube is often found in the upper part of the egg cytoplasm (Pl. VIII, fig. 2). The first proembryonal division occurs in the middle region of the egg cell (Pl. VIII, fig. 3). The spindle of the mitosis is very small and is intranuclear in its origin. The orientation of the axis of the spindle is variable but in most cases is inclined to the long axis of the egg cell. In the telophase of the first division, on the equatorial region of the spindle, several basophilous granular bodies are accumlated (Pl. VIII, fig. 4; Pl. IX, fig. 19). These granules gradually disappear with the progress of the stage. The granular cytoplasm surrounding the fertilized nucleus is not now able to envelope completely the daughter nuclei formed by the first division. The daughter nuclei become larger and larger and perform the second division in about the same position as the first (Pl. VIII, fig. 5). The orientation of the axes of these two spindles is also variable. In the telophase of the second division, basophilous granules are also found on the equatorial region of the spindle (Pl. VIII, fig. 6). Four nuclei formed by the second division increase in size and pass down towards the bottom of the archegonium where they dispose themselves in a right-angled plane to the long axis of the archegonium (Pl. IX, fig. 7). After this stage no proteid vaculoe is found in the cytoplasm. Then, the third division takes place (Pl. IX, fig. 8). The axes of the four spindles agree with the long axis of the archegonium, so in the final stage of this mitosis two tiers, each of four nuclei, are found. Now, the wall formation takes place and two tiers, each of four cells, are formed but in the upper tier, the part towards the archegonial cavity is not closed by the cell wall (Pl. IX, fig. 9). The upper tier then divides into two tiers each of four cells (Pl. IX, fig. 10). In this case too, the cells of the uppermost tier are not closed towards the archegonial cavity. In the next stage, the lowest tier divides into two tiers, each of four cells (Pl. IX, fig. 11). Now the proembryo consists of four tiers (Pl. IX, fig. 12), the uppermost tier being the open cell tier, the second the rosette cell tier, the third the primary suspensor tier and the lowest the embryonic tier. At this stage, the proembryonal development comes to an end.

The post-embryogeny begins by the elongation of the primary suspensor, the third tier in the final stage of the proembryo. The cells of the embryonic tier do not divide, until a considerable elongation of the primary suspensor has taken place (Pl. IX, fig. 13; Pl. X, fig. 21). Then, the embryonic tier divides into two tiers, each of four cells (Pl. IX, fig. 14; Pl. X, figs. 20, 22) and the lower tier divides again, thus at the apex of the primary suspensor, three tiers, each of four cells, are formed (Pl. X, fig. 23). After considerable elongation of the primary suspensor, the uppermost of the embryonic tiers elongates as the first part of the secondary suspensor (e_1) (Pl. X, fig. 24). But, the embryonic tier becomes again three tiers, perhaps by the transverse division of the lowest tier, and the tier next to the e_1 then elongates as the second part of the secondary suspensor (e_2). In the same way the third to the fifth parts of the secondary suspensor (e_3, e_4 and e_5) are formed (Text-fig. 1, a, b). At the beginning of the elongation of the e_3, the e_1 and the e_2 of the secondary suspensor still continue the elongation, causing tortuous windings. Later, the e_3 and the e_4 also make windings just in the same manner. After the e_5 has somewhat elongated, the cells of the embryonic tier begin to divide repeatedly (Pl. X, fig. 26). These cells lying at the apex of the suspensor are at first intimately united, as if they were destined to form a single embryo. But in further course of development a cleavage of the embryo occurs, each of the four embryonic initials forming a separate embryo independently. Cleavage of the primary embryo is not found in *Picea*, *Abies**, *Larix* and *Pseudolarix*. And in *Pinus*, *Tsuga* and *Cedrus* cleavage sets in earlier than in *Keteleeria*, it takes place in the early formed portion of the secondary suspensors, in rare cases even in the primary suspensor. In *Keteleeria*, cleavage occurs only in the last-formed embryonal tubes (Pl. X, figs. 27, 28; Text-fig. 1, c; Text-fig. 2, a, b). The four embryos thus



Text-fig. 1. Whole embryo. a–b, Elongating stage of the sécondry suspensors. ×20. c, Elongating stage of the massive embryonal tubes. ×15.



Text-fig. 2. a, Cleavage of the primary embryo. ×80. b, The same, more advanced. ×50.

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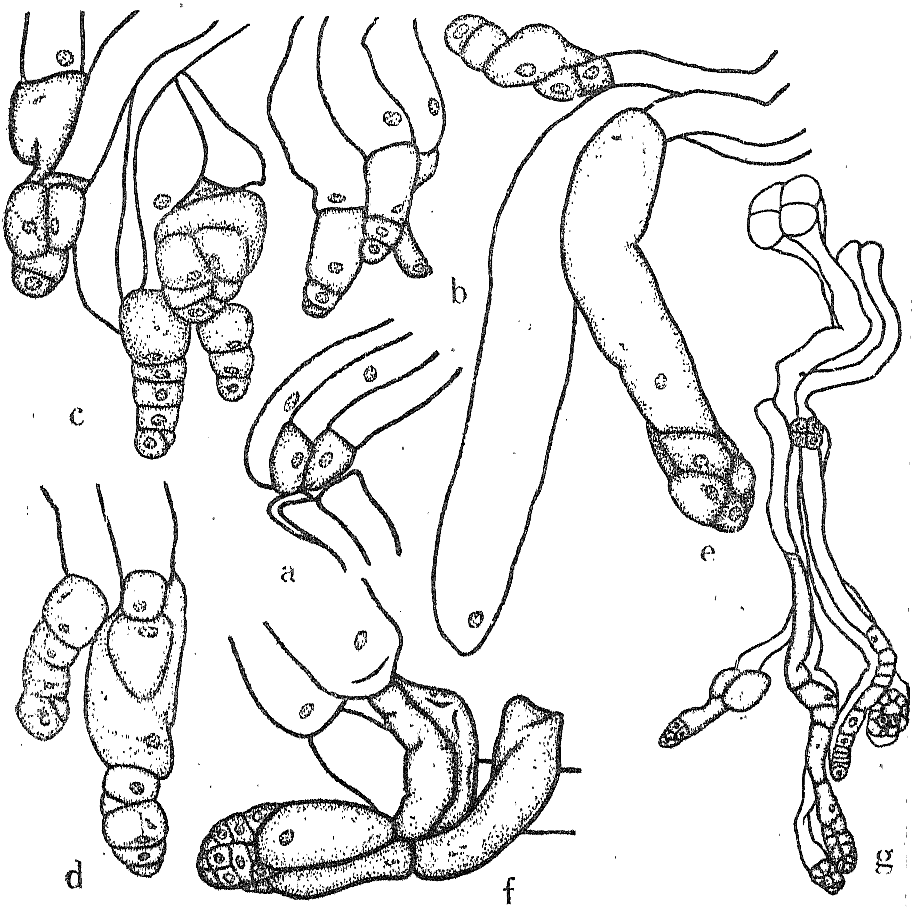
*In *Abies*, according to HUTCHINSON ('24) and BUCHHOLZ ('26, '31) a small per cent of cleavage polyembryony is found.



Text-fig. 3. Embryos developed from the suspensor cells. a–f, ×140. g, ×40.

formed sometimes manifest differences in their development. Moreover in some cases, each embryo forms in its lateral portion an additional embryonic cell-mass. Then, in each embryo, the cells next to the e elongate and form the embryonal tubes, the remaining portion becoming the embryo proper (Text-fig. 2, a, b). When the formation of the e_3 of the secondary suspensor is completed, the primary suspensor and the e and the e_3 of the secondary suspensor begin to degenerate, but the e_1 of the secondary suspensor becomes meristematic and cuts off the embryonic cells, which later divide repeatedly (Text-fig. 3, a–g) and sometimes develop an embryo with embryonal tubes of its own (Text-fig. 3, f). But no regularity prevails as to the course of development of this embryo. In some cases the cells of the primary suspensor and the e_2 and the e_3 of the secondary suspensor also become embryonic. In rare cases, rosette embryos are also found (Pl. X, figs. 29, 30). In cases in which the rosette embryo is not formed, the rosette cells are still alive when elongation of the e_5 takes place.

In conclusion, the cleavage polyembryony is a characteristic in the embryogeny of *Keteleeria* and occurs in three different ways, as follow: Firstly, the cleavage polyembryony takes place by the rejuvenescence of the suspensor cells. Up to the present, among the members of *Abietaceae* and *Pinaceae* such a kind of polyembryony is found only in *Pseudolarix* (BUCHHOLZ, '31). Secondly, the cleavage polyembryony is caused by the cleavage of the primary embryo. In this respect *Keteleeria* bears a resemblance to *Pinus*. But in *Pinus*, cleavage occurs in the early formed portions of secondary suspensor. Embryonal development of this type was also found once in *Keteleeria*. The writer, however, feels convinced that such a case will be an exceptional or abnormal case in *Keteleeria*. Thirdly, the cleavage polyembryony is brought about by the formation of the rosette embryo. But this kind of polyembryony does not often occur in *Keteleeria*.

The haploid chromosome number of *Keteleeria* was found to be twelve in the female gametophyte (Pl. IX, figs. 17, 18). This number agrees well with that of the many members of *Abietaceae* and *Pinaceae*.

SUMMARY

1) The male and female gametes, the fertilization and the embryogeny of *Keteleeria Davidiana* BEISSNER var. *formosana* HAYATA are described.

2) Two sperm nuclei differing in size are formed by a mitosis of a body cell.

3) The general structure of the archegonium of this species agrees with that of the other members of *Abietaceae* and *Pinaceae*.

4) The neck cells are arranged in most cases in four tiers, each of four cells. But variations in number are also found.

5) The ventral canal cell is found. This cell persists up to about the time of fertilization or still later.

6) In the archegonium, conspicuous proteid vacuoles are found.

7) The number of the archegonium in a female gametophyte is from five to ten, seven being most common.

8) The fertilization occurs about the 10th of June in Taihoku.

9) In fertilization, the apex of the pollen tube penetrates into the

egg cell for a considerable distance.

10) The proembryo formed in the basal part of the archegonium is composed of sixteen cells which are arranged in four rows, each consisting of four cells.

11) The components of an embryo are the open cells, the rosette cells, the primary suspensor, two kinds of secondary suspensor and the embryos proper.

12) The cleavage polyembryony of this plant takes place in three different ways, namely, first by the cleavage of the primary embryo, second, by the embryonal development of the suspensors and third by the development of the rosette embryos.

13) The embryogeny of this species seems to belong to an intermediate type between that of *Pinus* and that of *Picea*.

14) The chromosome number is twelve in the haploid generation.

This work was undertaken at the suggestion and with the criticism of Professor Dr. MASATO TAHARA to whom the writer wishes to express his sincere thanks. Thanks are also due to Professor Dr. S. HIBINO, Professor Dr. G. MASAMUNE, Professor Dr. Y. YAMAMOTO, Mr. R. KIKKAWA, Mr. T. SÔMA and Mr. K. YAMADA, through whose kindness so many facilities for the completion of the work were obtained.

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LITERATURE

BUCHHOLZ, J. T., 1926. Origin of Cleavage Polyembryony in Conifers. Bot. Gaz., **81**: 55-71, Pls. 5-7.

BUCHHOLZ, J. T., 1931. The Pine Embryo and the Embryos of Related Genera. Trans. Ill. State Acad. Sci., **23**: 117-125.

HUTCHINSON, A. H., 1917. Morphology of *Keteleeria Fortunei*. Bot. Gaz., **63**: 124-134, Pls. 7-8.

HUTCHINSON, A. H., 1924. Embryogeny of *Abies*. Bot. Gaz., **77**: 280-289, Pls. 17-20.

SUGIHARA, Y., 1941. The Embryogeny of *Cunninghamia lanceolata* HOOKER. Sci. Rep. Tôhoku Imp. Univ., 4th seri., Biol., **16**: 182-192, Pls. 10-11.

SUGIHARA, Y., 1941. Embryological Observations on *Taiwania cryptomerioides* HAYATA. Sci. Rep. Tôhoku Imp. Univ., 4th seri., Biol., **16**: 291-295, Pls. 19-20.

EXPLANATION OF THE PLATES

PLATE VIII

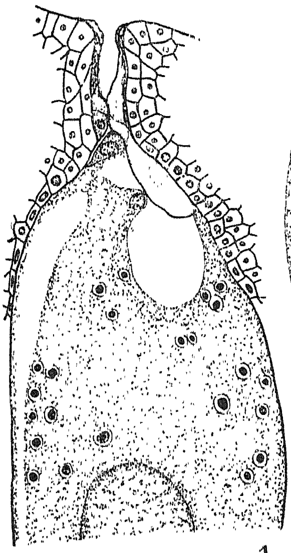
Fig. 1. Upper part of an archegonium showing the penetrating pollen tube. ×130.
Fig. 2. Fertilization. ×130.
Fig. 3. Metaphase of the proembryonal first division. ×130.
Fig. 4. Two nuclei in the telophase of the first division. ×130.
Fig. 5. Metaphase of the proembryonal second division, ×130.
Fig. 6. Four nuclei in the telophase of the second division. ×130.

PLATE IX

Fig. 7. Four nucleus stage in the archegonial bottom. ×130.
Fig. 8. Metaphase of the proembryonal third division. ×130.
Fig. 9. Eight nucleus stage after the wall formation. ×130.
Fig. 10. Mitosis in the upper tier. ×130.
Fig. 11. Mitosis in the lowest embryonic tier. ×130.
Fig. 12. The last stage of the proembryo. ×130.
Fig. 13. Beginning of the elongation of the primary suspensor. ×130.
Fig. 14. Mitosis in the lowest embryonic cells. ×130.
Figs. 15–16. Two sperm nuclei differing in size. ×400.
Fig. 17. Chromosomes in the metaphase of a mitosis in a female gametophyte. ×2240.
Fig. 18. Anaphase of the same. ×2240.
Fig. 19. Basophilous granules on the spindle fibres in the telophase of the proembryonal first division. ×790.

PLATE X

Fig. 20. A young embryo. ×100.
Fig. 21. Embryonic cells at the apex of the primary suspensor. ×230.
Fig. 22. The same in two tiers. ×230.
Fig. 23. The same in three tiers. ×230.
Fig. 24. Beginning of the elongation of the first secondary suspensor (e_1). ×230.
Fig. 25. Beginning of the elongation of the fifth secondary suspensor (e_5). ×230.
Fig. 26. Repeated divisions of the embryonic cells. ×230.
Figs. 27–28. Clear separation of four embryos. ×230.
Figs. 29–30. Rosette embryo. ×130.



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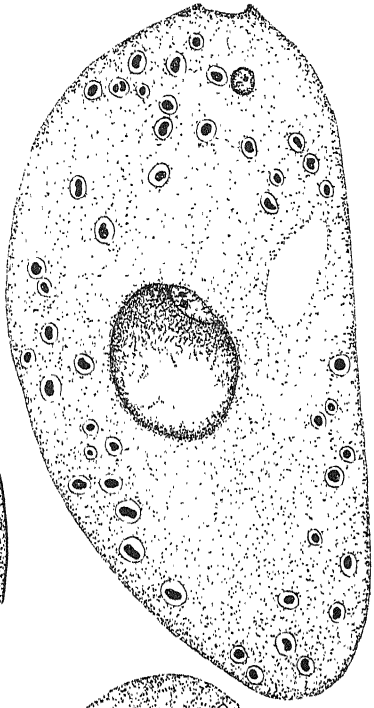

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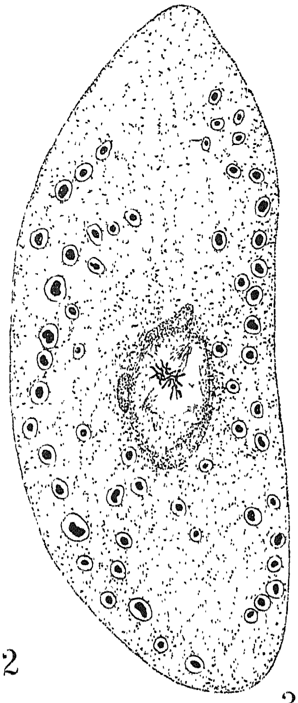

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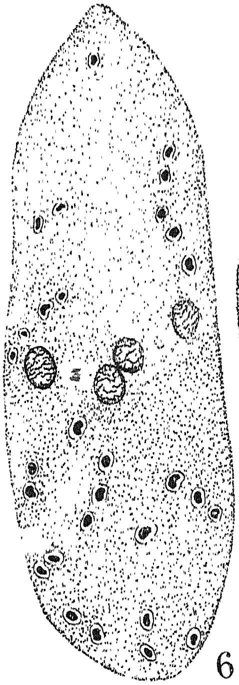

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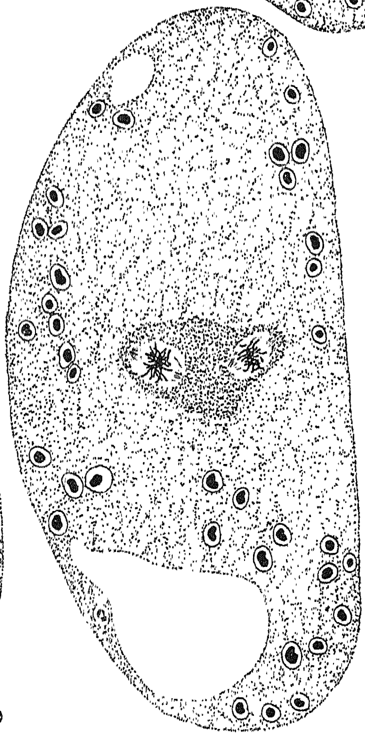

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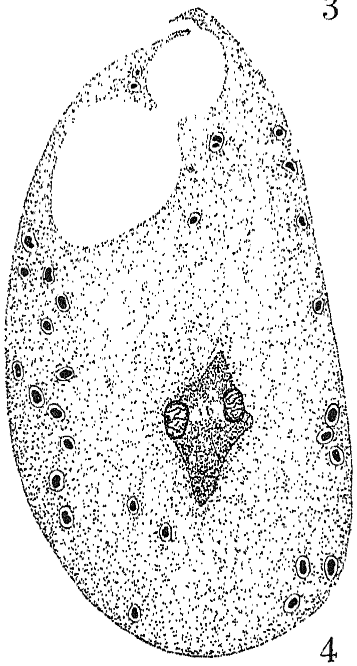

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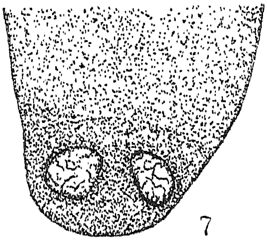
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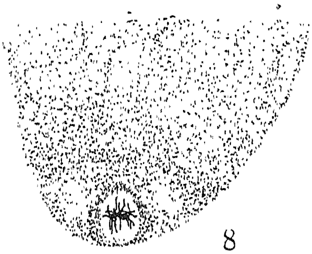
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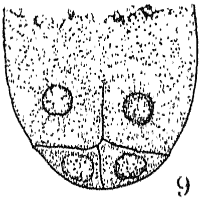
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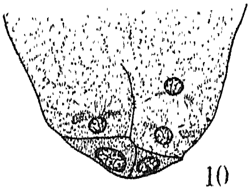
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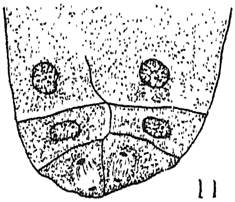
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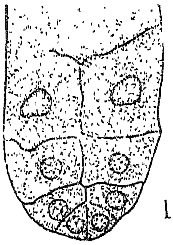
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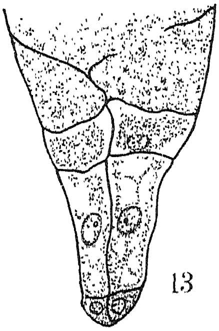
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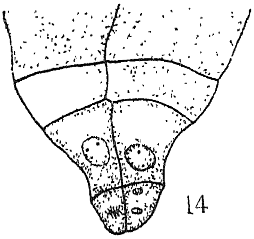
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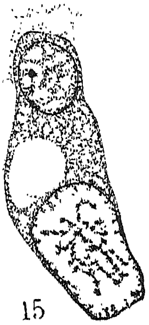
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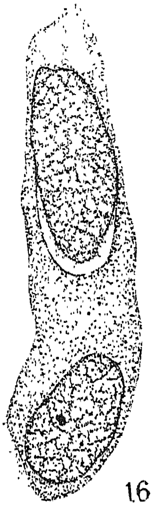
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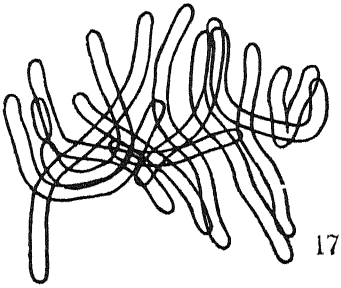
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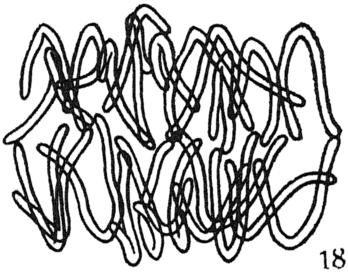
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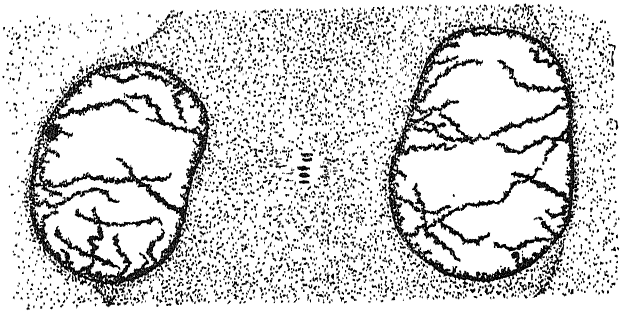
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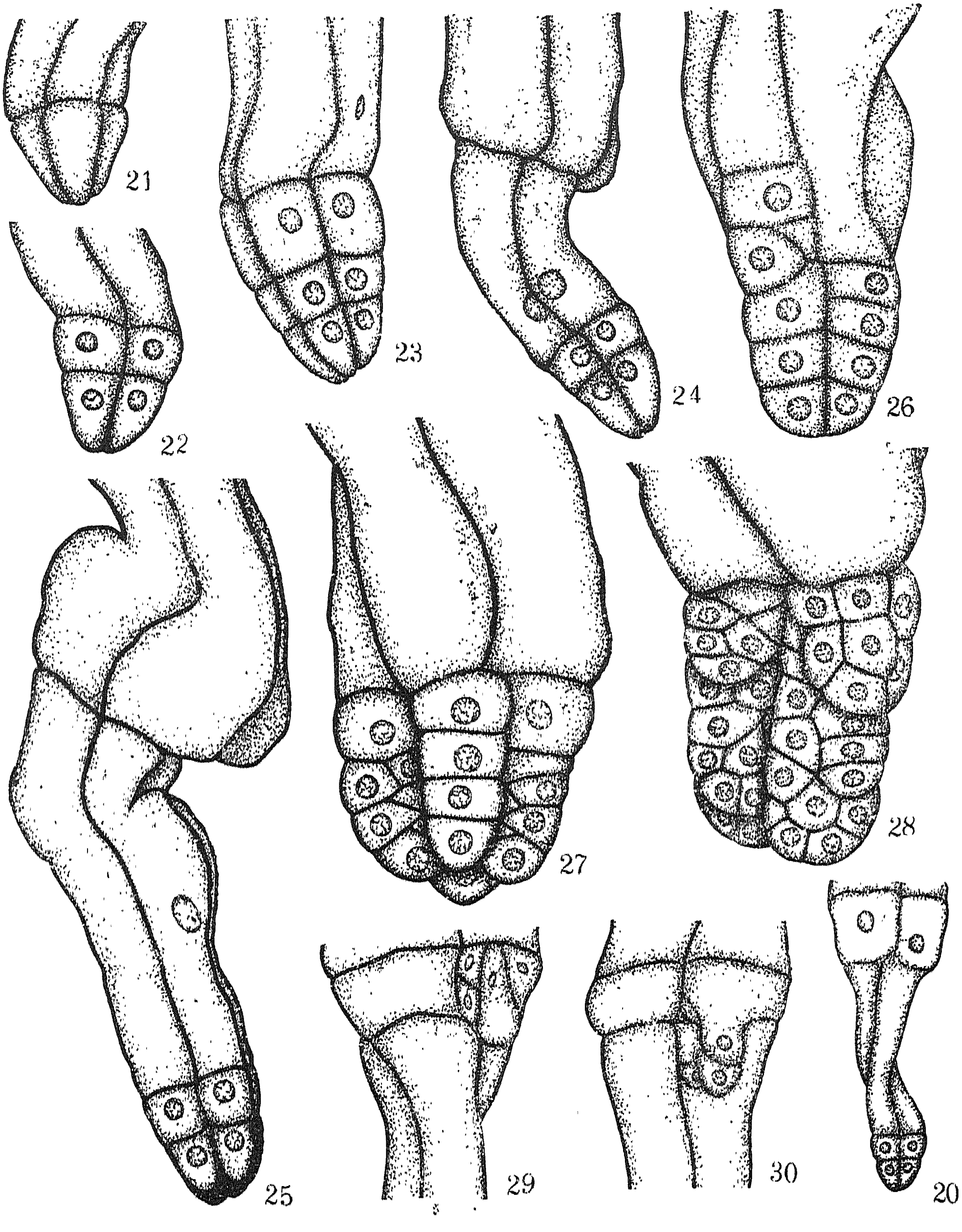

Y. Sugihara: Embryological Observations on *Keteleeria*.

PHYSIOLOGICAL STUDIES ON THE PIGMENTARY SYSTEM OF CRUSTACEA*

I. THE COLOR CHANGE OF A SHRIMP *PARATYA*** *COMPRESSA* (DE HAAN)

BY

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(With 8 Text-figures)

(Received August 15, 1942)

INTRODUCTION

In higher crustaceans there is a surprising, rapid and strong color change, whose efficiency is inferior only to that of cephalopods and chameleons. The first published instance of color change in the Crustacea is said to be that of *Hippolyte* (KRÖYER, 1842), and the first description of chromatophores is that of *Mysis* (SARS, 1867). The chromatophores in crustaceans contain several nuclei, and according to DEGNER (1912) they must be regarded as syncytial structures. The investigations of KEEBLE & GAMBLE (1900), FRÖHLICH (1910), FRANZ (1910), and PERKINS (1928) supply fundamental data concerning the migration of the pigment granules in the chromatophores.

The color change of the shrimp consists in the concentration or dispersion of some pigments mostly in an adaptation of the color of the body to the color of the background. This occurs in *Palaemonetes vulgaris* (PERKINS, 1928; BROWN, 1933-1935) and *Crangon vulgaris* (KOLLER, 1925-1930), whereas in other crustaceans such as *Uca* (MEGUŠAR, 1912; CARLSON, 1936; ABRAMOWITZ, 1937) and *Leander squilla* (HANSTRÖM, 1937), the color change manifests itself in periodical contractions and expansions of the chromatophores, independently of the light and the color of the background.

Since the work of KOLLER (1925, 1927) on *Crangon vulgaris*, in which

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*The expense of this study was defrayed by a grant to the laboratory of Prof. S. NOMURA from the Scientific Research Expenditure of the Department of Education, to which the author has the pleasure of taking this opportunity to express his cordial thanks.

***Atephyra*, *Xiphocaris* and *Xiphocaridina* have sometimes been employed as the genus name of this shrimp.

he was able to observe a distinct reaction of the chromatophores by blood transfusion, it has been suspected that all chromatophores might be under the control of humoral substances carried in the blood. This view was strengthened by the fact that no one had been able to demonstrate nerve endings in the chromatophores of the crustaceans. This idea was followed up by PERKINS who in 1928 published an account of the color changes in another Atlantic shrimp *Palaemonetes vulgaris*. PERKINS was unable to repeat with success the experiment on the transference of blood as carried out by KOLLER on *Crangon*, but he sought in the body of *Palaemonetes* for an organ that might secrete a humor controlling the color-cells. This he finally found in the eye-stalks of the shrimp. He showed that a substance was localized in the eye-stalk of the animals which, when injected into the blood, would bring about a concentration of the red and yellow pigments. For several years following this discovery, it was generally believed that the eye-stalk hormone acted as a contracting hormone for the chromatophores of crustaceans.

In consequence of this action, the eye-stalk hormone has been termed 'contractin' by KOLLER (1930) in opposition to 'expantin' which might be a dispersing hormone for the chromatophores. The presence of such a chromatophore-activating substance, concentrating the red and yellow pigments in shrimps, has since been confirmed in several other species of higher Crustacea by KOLLER (1929), KOLLER & MEYER (1930), SMITH (1930), PERKINS & KROPP (1932), KROPP & PERKINS (1933), HOSOI (1934), STEPHENSEN (1934), HANSTRÖM (1935, 1937), CARLSON (1935, 1936), BROWN (1934, 1935, 1938, 1939) and ABRAMOWITZ (1936, 1939, 1940), etc.

The physico-chemical nature of the eye-stalk hormone, has also been investigated by many authorities, but we do not know much about it except its physiological characteristics. The direction of this field of work has since tended into the quantitative determination of the effects of these substances upon the animal color change. Recently, ABRAMOWITZ reporting about the chemical nature of this substance said that the chromatophorotropic hormone, or hormones, in the eye-stalks of *Uca pugilator* reacted in a characteristic fashion for amio bases.

The present author was stimulated by these features of the problem to undertake a re-investigation of the subject with the idea of making fundamental observations on the behavior of the crustacean chromatophore, with special attention to the eye-stalk hormone and its connection with the color change of the common fresh water shrimp in our country.

The work has been carried out at the Biological Institute, Tôhoku Imperial University in Sendai from 1939. It was accomplished under the direction of Prof. Dr. S. NOMURA to whom I am deeply grateful for many suggestions.

MATERIAL

By reason of its readily observable color changes and the ease with which it can be collected and cared for in the laboratory, *Paratya compressa* (DE HAAN) was used as the material for the investigation. This shrimp is a common fresh water animal in the vicinity of the laboratory. The animal, if kept in a large vessel, can live in the laboratory for many months in a healthy condition. It is not difficult to catch in abundance shrimps of 1.5–2.5 cm. body length during the season from spring to the later part of autumn. In winter, if the water is not frozen, they may be obtained with some difficulty by seining in pools.

OBSERVATIONS AND EXPERIMENTS

A. Responses of chromatophores to various backgrounds.

On a light sandy bottom the shrimps are in a light tone matching the surroundings; on a dark muddy bottom they become correspondingly dark, varying individually from blue black to chocolate-brown. In almost any situation of their natural environments, they can be detected only with difficulty because of their adaptive coloration.

When the shrimps are brought into the laboratory and kept in a large vessel, they live very well for many months. The animal is transferred from the stock supply into a Petri-dish when needed for observation. Various colored backgrounds were employed for the fundamental observation of the dermal chromatophore reaction. The pigmentary system of this shrimp consists of four colors: red, yellow, white and blue. The ultimate states, which these four pigments assume in response to various colored backgrounds, have been summarized in the following table.

Thus I have obtained the same results on the whole as were obtained by BROWN ('35) in *Palaemonetes vulgaris*. In such a manner, the color changes of the animals are also brought about by the dispersion (expansion) and concentration (contraction) of pigments in the chromatophores. The processes of the chromatophores contain red and yellow pigments, which flow proximally or distally along preformed pathways in the hypodermis. The red pigment is said to be astacin, and the yellow one,

TABLE I.

Reaction of dermal chromatophores to various backgrounds and operation.

Background or operation	Red pigment	Yellow pigment	White pigment	Blue pigment
White	c.	c.	d.	absent
Green	c.	c.	d.	present
Red	d.	d.	d.	absent
Blue	c.	c.	c.	present
Black	d.	d.	c.	present
*Extirpation of eyes	d.	d.	d.	absent
Black painting of eyes	d.	d.	d.	absent

In the table, c. means the concentrated state and d. means the dispersed state of the pigments of chromatophores.

*The explantation of this experiment is described later in the text, but it was inserted in this table for comparison with other cases.

carotin. The blue one is irregularly and sparsely distributed in the hypodermis and is seen as pale yellow by reflected light. It may probably be derived from the red pigment as discussed later. All four pigments above mentioned can occur in the same chromatophore, whereas monochromatic chromatophores are always sepia brown and do not change color in any case.

When a shrimp, which had been of a dark phase in the pond, was put into a white dish, the final result was a complete contraction of all the chromatophores. Accompanying this there was formed, chiefly in the vicinity of the chromatophores, a blue coloration which surrounded them, and later permeated the tissues like a dye. It was first seen about two or three minutes after the animal had been transferred to the white dish from its natural environment and appeared most distinctly at first at the bases of the antennal exopodites, in the heavily pigmented regions over the gills, and finally all over the body. The blue coloration increased in intensity up to an hour and was accompanied by the gradual contraction of the chromatophores. During the second hour, the red and yellow pigments were withdrawn into their respective centers and the blue one disappeared. The animal was now pale and transparent, having been completely adapted to the white background.

As the chromatophores expand or contract in respones to a black or white background, the question arises as to whether this is a response to differences in light intensity or to the different wave lengths of the light rays reflected from the background. This may be determined by subjecting the shrimps in a black vessel to a high intensity of light, and those in a white vessel to a low intensity. It was found that in all cases there was the same degree and rapidity of expansion of chromatophores on a black background as there was of contraction on a white one, regardless of the intensity of light.

The time necessary for the chromatophores in *Paratya compressa* to change from one extreme state to the other varied with the individual, but the average time was from one to two hours. A noticeable change of color in the animal as a whole may be seen in from three to five minutes after the beginning of stimulation (cf. Paragraph G.), this being much more readily observed in the change from dark to light backgrounds, because of the presence of the blue coloration produced under those circumstances. The intensity of the change increased rapidly up to an hour, when the animal appeared definitly light or dark. During the second hour the pigment masses expanded to the extreme condition. Both red and yellow substances migrated respectively at about the same rate as in a chromatophore.

The size of these chromatophores varies in individual cases from 0.2 mm. to 0.01 mm. in diameter. Their numbers and distribution in this shrimp can not be determined so easily, but their approximate numbers are given in Table II. The body of this animal may be conveniently divided into various parts as shown Fig. 1. (Schema.)

TABLE II.

The approximate numbers of chromatophores in *Paratya compressa.*

Body length	Parts of the body										
	E	A	C	Ab.							T
				I	II	III	IV	V	VI	VII	
1.5 cm. male	37	24	307	28	92	170	143	78	70	122	267
	1338										
2.0 cm. male	1778										
2.2 cm. male	2686										
2.5 cm. female	3352										

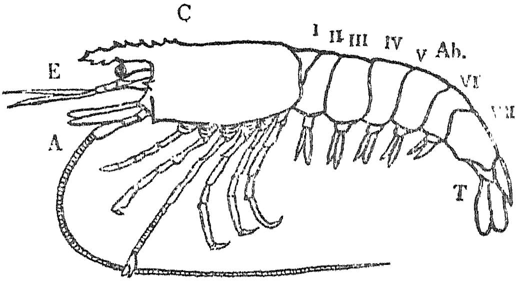


Fig. 1. The body of this shrimp was divided into various parts for the calculation of the chromatophores.

When the whole animal is placed in absolute darkness, however, there is a complete concentration of pigment to the chromatophore centres regardless of the color of the background on which the animal has previously rested. Animals which had been completely black-adapted were put into a dark-room, and after two hours were found to be pale and transparent, with the chromatophores completely contracted. If the animal had been white-adapted before, it remained so regardless of the time it was kept in the dark. This state of affairs is just the opposite to that of placing the animal on a black background. In other words, there is a great difference between the effect of the blackness of a background and the absence of light. In the former case there results a complete contraction. It is a peculiar circumstance that darkness should produce the same effect as a white background. This phenomena will be dealt with again under the heading of Discussion.

B. Effects of temperature upon the chromatophores.

Some authorities believe that the chromatophore of crustaceans is stimulated directly by warmth or cold, while others do not accept it. My experimental observations revealed that in the chromatophores of this shrimp, the red pigment alone seemed to expand while other pigments remained in the same state, regardless of the color of the background, when the temperature of the water was raised from 22° to 30°C (Fig. 2).

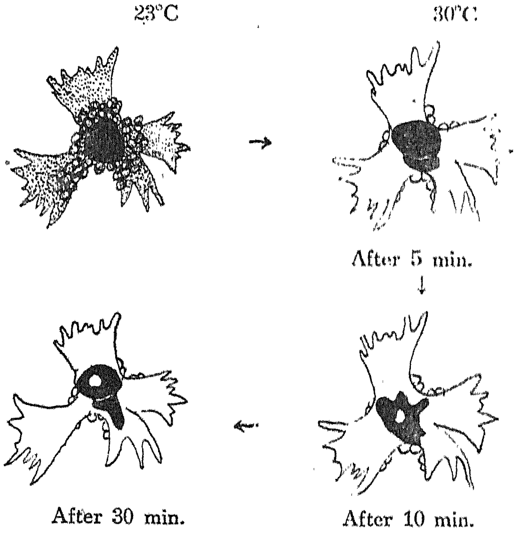


Fig. 2. The effect of temperature upon the chromatophore. Red pigment: black, yellow pigment: white, blue pigment: circle.

C. Effects of ions.

The animals were kept in such various solutions as 1/10 N KCl, NaCl, $CaCl_2$. As far as these solutions are concerned, no definite direct effect of ions was recognized, since the response was very sluggish and considerably divergent.

D. Effects of carbon dioxide.

The effects of carbon dioxide on the chromatophores of this shrimp were examined, using water in which was dissolved a greater quantity of carbon dioxide gas than in normal tap water. Kipp's apparatus was used as the generator of carbon dioxide gas. To its generator was connected a washing bottle, containing a saturated sodium bicarbonate solution, by which excessive hydrogen chloride and other substances were absorbed. CO_2 gas from the generator was passed through the tap water, and the solution thus obtained was taken as the standard; 1/2, 3/4, 7/8 and 15/16 diluted solutions were prepared when needed. The animals were submerged into these solutions, as the experiment required.

The content of carbon dioxide and the hydrogen ion concentration of the solutions above mentioned are given in the following table.

TABLE III.

Kinds of solution	pH	*CO_2 content, %
Standard	4.9	57.3
1/2 diluted	5.3	24.8
1/4 diluted	5.5	9.9
1/8 diluted	5.6	5.1
1/16 diluted	5.8	1.6
Normal tap water	6.9	0.3

*The content of the carbon dioxide in the water was determined by van Slyke's volumetric method.

In immersion experiments with such solutions, it has been seen that the chromatophores, which had contracted by white adaption, expanded considerably and rapidly in proportion to the carbon dioxide content of the water. The results are shown in Fig. 3. The observation in this case was always made on a white background and at a temperature of 19°C.

The injection of the solutions (0.025 cc.) containing the greater quantity of carbon dioxide gas into the abdomen produced more remarkable effects on the dermal chromatophores than did the immersion experiment above mentioned. The result of this experiment is shown in Fig. 4.

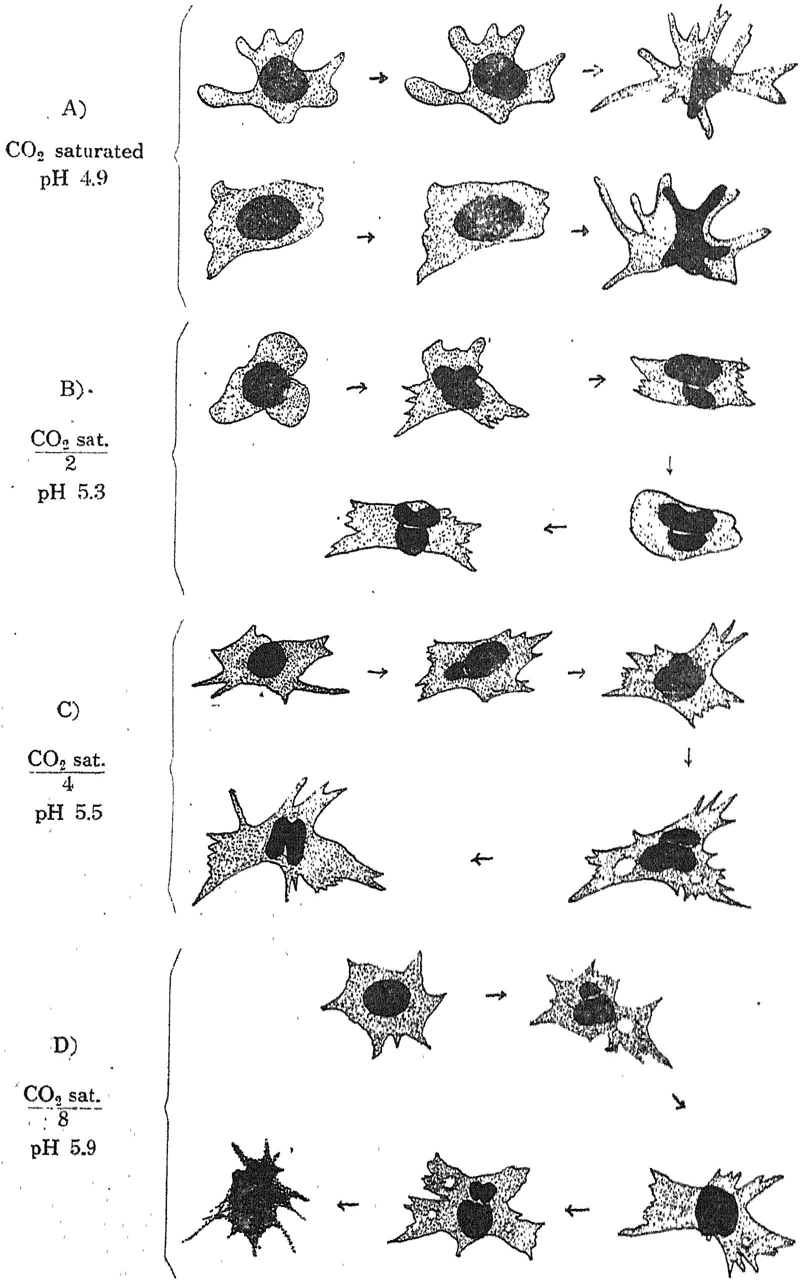

A)
CO_2 saturated
pH 4.9
B)
$\frac{CO_2 \text{ sat.}}{2}$
pH 5.3
C)
$\frac{CO_2 \text{ sat.}}{4}$
pH 5.5
D)
$\frac{CO_2 \text{ sat.}}{8}$
pH 5.9

Fig. 3. The chromatophore behavior in water containing various amounts of carbon dioxide in solution. A) CO_2 saturated (pH 4.9), B) $CO_2/2$ (pH 5.3), C) $CO_2/4$ (pH 5.5), D) $CO_2/8$ (pH 5.9) Red pigment: black, yellow pigment: stippled

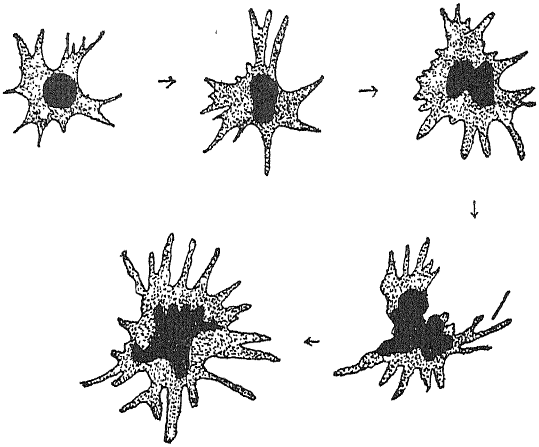


Fig. 4. The chromatophore behavior in the injection experiment with CO_2 saturated water.

But, when the water in which was dissolved CO_2 less than ca. 9% was injected into the abdomen, the recovery of the contraction of the chromatophores occurred, (cf. Fig. 7) while more concentrated solutions brought about the death of the animal with the chromatophores in a state of expansion.

The time relation, between the hydrogen ion concentration and the chromatophore expanding reaction by the carbon dioxide will be described in a later paragraph, in connection with the results of other experiments.

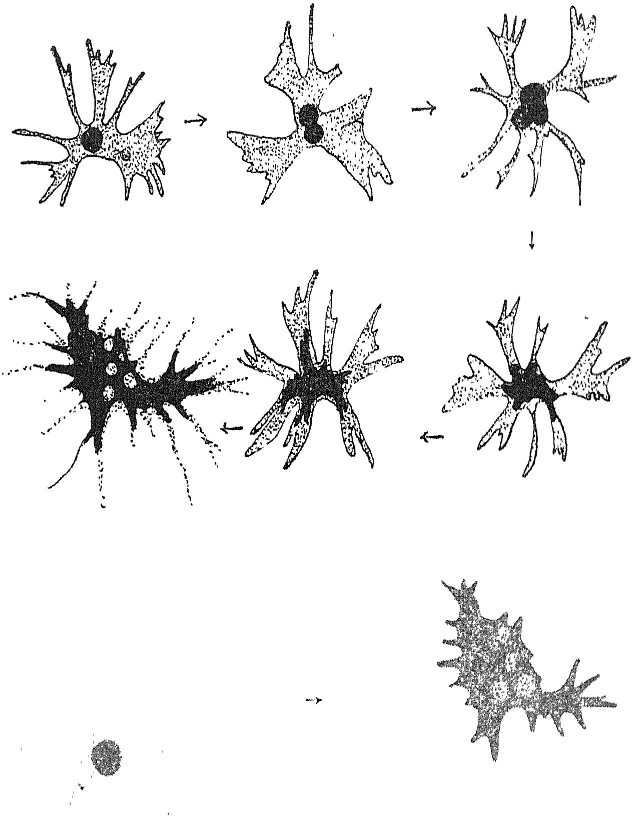
E. Effects of the removal of eyes upon the dermal chromatophore.

Perhaps the most widely investigated aspect of the chromatophore physiology in Crustacea has to do with the effect of the removal of the eyes upon the dermal chromatophore. For this purpose, I have performed the "blinding" experiment by two methods. The first method was excision of the eye-stalks and the second was covering the eyes with an opaque substance. But the removal of the eyes (up to the retinal portion of the eye-stalks) and removal of the entire eye-stalks are of quite different significance, as far as the chromatophorotropic reactions are concerned. In the former procedure the retina is isolated, but the endocrine gland (probably the sinus gland by HANSTRÖM) would be intact; in the latter both retina and internal secrectory gland are removed (Fig. 5).

The smearing of the crustacean's eyes was carried out according to my own new technique using a mixture of black indian ink and canada balsam. This is very convenient for treatment and the mixture is water resistant. In case of need, it can be taken off by a solvent such as xylol.

In all instances blinding was followed by an expansion of the red and yellow pigments which are the chief pigments of the chromatophores. Thus the animal grew dark after blinding.

It may be seen that here we have a receptor-effector system with the



First state End state

Fig. 5. The chromatophorotoropic behavior in the extirpation of the eyes.

eyes receiving the stimulus which is carried to the chromatophores as end organs. It has always been supposed that, in as much as the eyes are intimately connected with the nervous system, there must be a nervous impulse set up which in some way reaches the chromatophores, the endocrine organ such as the sinus gland being assumed to be its possible mediator.

F. Effects upon the chromatophore behavior by the injecting of water extracts of the eye-stalks.

Since KOLLER's epoch-making discovery ('28) of the eye-stalk hormone for the crustacean color change, many attempts have been made concerning the chromatophore activating substances. I have tested here simply the effects of such a substance upon the chromatophore behavior. Ten individuals of *Paratya compressa* were killed with hot water and the eye-stalks were taken off. The twenty eye-stalks were macerated in 5 cc. of RINGER's solution* for amphibians, boiled, centrifuged, and the clear extract was decanted off and cooled. Then the extract was diluted with RINGER's solution to 1/10, 1/100, 1/1000, etc. A dose of 0.025 cc. of each dilution thus prepared was injected into the haemocoecal cavity of blinded animals (*Paratya compressa*) from the lateral side of the third abdominal segment in order to see if the color of the shrimp would change from a reddish to a pale hue.

The rest of the original extract, from which portions used for the above dilution were taken out, was dried and weighed for subsequent calculation. Experiments were carried out at a temperature varying from 17°–18°C. For preliminary orientation I first used undiluted extracts. One injection of 0.025 cc. corresponds to 0.003125 mg. of the wet weight of the eye-stalks.

The injection of the extract into the blinded animal caused a marked contraction of the pigment granules in the chromatophores. The effect manifested itself in a few minutes and then lasted for several hours. Extracts of the other parts of the animal had no effect on the color change. The RINGER or other salt solution does not bring about the concentration of pigment.

It might be supposed that, inasmuch as the eyes are essential for the functioning of the color changes, they serve as endocrine organs under certain conditions of light stimulation. By the injection of the extract from the eye-stalks adapted to light for a long time, there came on within a few minutes a striking contraction of hitherto refactory chromatophores, together with the blue coloration which is so characteristic of the change from the dark to the light phase. Within an hour, the blinded animal was nearly as light in color as a normal one which is white adapted. This period of contraction lasted for twenty hours, then the chromatophores again expanded to their previous state.

It was found that the smaller the amount of the substance contained in the injected solution, the shorter becomes the duration of the pigment concentration untill only a slight migration takes place and finally the reaction becomes almost imperceivable.

In this experiment I have not tested how the substance is distributed in the eye-stalk itself, because the latter is very small in this shrimp. This may be carried out quantitatively with some other large shrimps later on.

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*NaCl 0.65%, KCl 0.02%, $CaCl_2$ 0.02%, $NaHCO_3$ 0.01%.

The eye-stalk extract of *Paratya compressa* was efficacious for as long as eight days without any diminution in its action. The dried eye-stalks keep the effective substance for many months.

KOLLER ('28) has reported the occurrence of the reverse phenomenon, namely, expansion of chromatophores of white-adapted shrimps induced by extracts from the rostral region of dark-adapted *Crangon vulgaris*. I also have repeated this experiment with *Paratya compressa*, but it has failed of experimental confirmation.

G. Effects of eye-stalk hormone upon an amphibian larva and a fish.

In 1929, KROPP reported the presence in the eyes of black-adapted shrimps of a substance effective in producing expansion of melanophores in white-adapted *Fundulus* and tadpoles of *Rana clamitans*. In this case the use of extracts from eyes of white-adapted tadpoles gave no results on black-adapted animals. Here, as in the case of the invertebrates, evidence pointed to the presence of a substance in the eye-stalk of the shrimp, which under proper conditions, induced effects on vertebrate chromatophores.

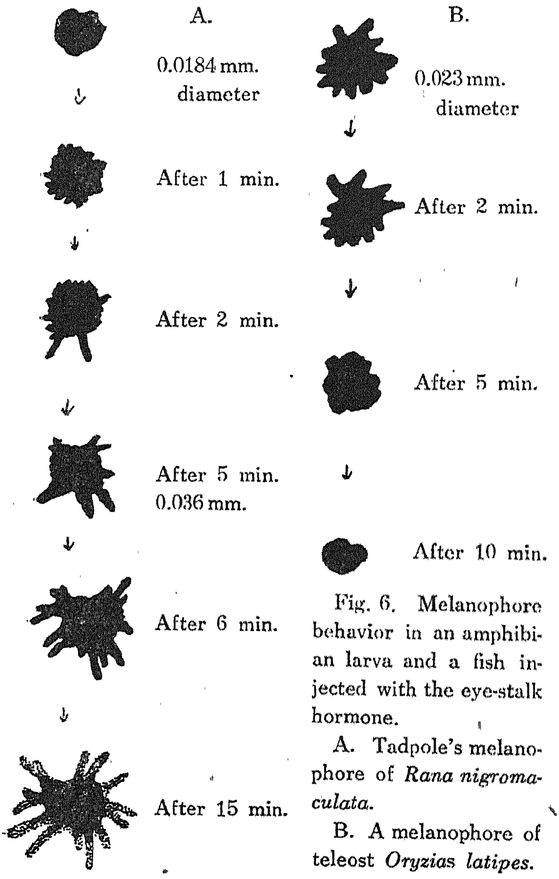

Fig. 6. Melanophore behavior in an amphibian larva and a fish injected with the eye-stalk hormone.

A. Tadpole's melanophore of *Rana nigromaculata*.

B. A melanophore of teleost *Oryzias latipes*.

The object of the experiment was to test the interspecificity of the chromatophore activator found in the crustacean eye-stalk, and further thus to establish its hormone nature.

The tadpoles of *Rana nigromaculata* HALLOWELL were placed in white or black dishes until their skin melanophores were nearly maximally contracted or expanded respectively. Each individual then received 0.025 cc. of the extract in the dorsal lymph sinus. Animals adapted to a black background showed no obvious melanophore reactions to the injection. The animals adapted to a white background, however, did show pronounced effects. Within five minutes of the injection these tadpoles began to darken over most of the dorsal surface, even though they remained on white background. Maximum darkening was reached often in about thirteen minutes. White-adapted controls received 0.025 cc. of RINGER's solution. They did not at any time show marked changes in pigmentation.

The injected substance produces opposite effects in shrimps and tadpoles, producing contraction of chromatophores in the former and expansion in the latter. This is an example of a hormone producing different results depending on the reacting system of color change of types of chromatophores (Fig. 6 A).

PERKINS and KROPP ('32, '33) have recognized that the eye-stalk extracts of *Praunus* and *Crangan* effect contraction of the melanophore of some fishes (*Gobius*, *Pleuronectes*). I have repeated this experiment using *Oryzias latipes* (TEMMINCK & SCHLEGEL). The results of this showed that the eye-stalk extract of *Paratya compressa* contracted the melanophores of the fish (Fig. 6 B).

H. The chromatophore index and the time relation curve.

By LANCELOT HOGBEN and DAVID SLOME ('31, '36) the so-called melanophore index was used for the studies of color change in the amphibian pigmentary system. That is to say, arbitrary numerical expressions have been proposed for five stages of melanophore contraction and expansion, selected as suitable for convenient identification and for defining the state most characteristic of certain equilibrium conditions. I have devised the chromatophore index of the crustacean color change as a modification of the melanophore index. This is illustrated in Fig. 7.

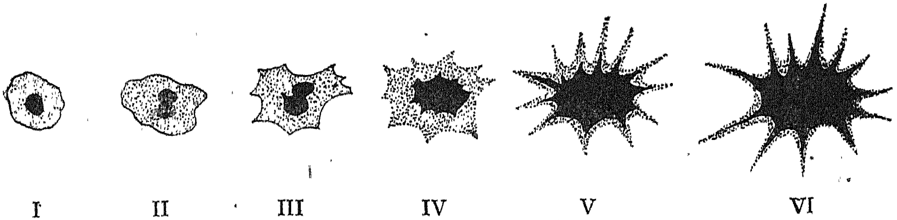

Fig. 7. Chromatophore Index

But it must be borne in mind that the numerical indices applied to different configurations of the crustacean chromatophores are quite arbitrary, for the pigmentary system of the shrimp differs from the amphibian melanophore system in its complexity. So the two pigments, red and yellow, were selected as the symbols considering their typical correlated behavior. Though some information may be obtained from considerations of the time intervals between equilibrium conditions and their intermediate phases, no definite significance can be attached to the gradients of the time relation curve.

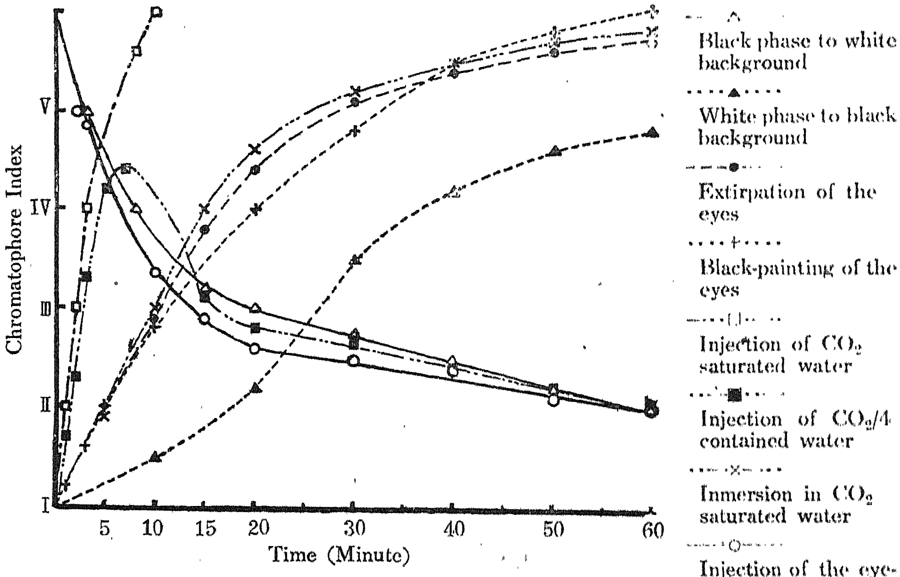

Fig. 8. Time relation curve

We shall here consider summarily the time relations of the chromatophorotropic responses involved in:

a) complete reversal of the white- and black-background response in both directions. I have observed what happens when the animals which have been adapted in a white-background in the light, are transferred to a black-background in the dark room and vise versa. Here, the equilibrium was reached more rapidly in passing from dark to light than from light to dark. This result is very signficant in the physiology of the higher decapod color change.

b) submersion in the carbon dioxide solution (as described in paragraph E.).

c) injection ofthe carbon dioxide solution into body (as described in paragraph D.).

d) extirpation of eyes (as described in paragraph E.).

e) black painting of the eyes (as described in paragraph E.).

f) injection of the hormone which was extracted from the white adapted eye-stalk (as described in paragraph F.).

It was shown that the rate of the expansion of the chromrtophores caused by the extirpation or black-painting of the eyes was very rapid compared with that of the normal animal in dark adaptation.

The expansion of the chromatophores following the injection of CO_2 saturated water was still more rapid than the expansion after the extirpation of the eyes.

DISCUSSION AND CONCLUSION

The term 'internal secretion' was already used in 1910 in connection with chromatophoral functions in crustacea by DOFLEIN, who referred to the blue pigment in shrimps. This blue pigment is developed in various species in relation to the contraction of the red and yellow chromatophores. When the animal has been put into a light dish, a bluish cloud surrounds the red and yellow chromatophores and the blue color permeates the surrounding tissues. According to KEEBLE & GAMBLE (1900, '10) the blue pigment (which is not granular) is derived from the red one, an opinion confirmed by BROWN ('35) in *Palaemonetes;* KOLLER ('36), however, regards the yellow pigment as the source of the blue coloration in *Leander adspersus*. In my observation of *Paratya compressa*, there was an evident disappearance of blue pigment in about two hours when the animal was placed on a white background. This fact can be most easily observed in shrimps taken out of the pond just before the experiment.

Whereas some authors believe that the crustacean chromatophores can be directly stimulated by light and temperature (GAMBLE & KEEBLE, 1900; MEGUŠAR, '12; BAUER & DEGNER, '13; SMITH, '30; GIERSBERG, '31), others (MATZDORFF, 1883; TAIT, '10; KOLLER, '27; PERKINS, '28; PARKER, '30) maintain that this is not the case. SMITH ('30) found that the chromatophores in *Macrobrachium acanthurus* expand in water of temperatures between 6° and 15°C and between 35° and 40°C independently of the background color. I have observed the expansion of the red pigment between 23° and 30°C. Thus temperature would act indirectly through the nervous system, and primarily it would affect the nervous center of the color change gland in such a manner as to prevent the release of the hormone, which will be discussed later.

In *Crangon* (Koller, '25, '30) there are four different pigments in the polychromatic chromatophores, whereas monochromatic chromatophores contain only sepia brown (melanin according to Verne, '21). After experiments with backgrounds of different colors and light intensities, Koller proved that *Crangon* is able to accommodate its color to white, black, yellow, orange and red backgrounds by dispersal of some and concentration of other pigments. This is the case in *Paratya compressa*, there being white, red, yellow and blue pigments in the chromatophore. In the process of the response of the chromatophore, the quality of the reflected light from the background, and not the light intensity, is the sole and decisive factor.

In specimens of *Palaemonetes vulgaris* with unimpaired vision the white chromatophores, contrary to the red and yellow ones are usually contracted on a dark background and expanded upon a white one in light, whereas they are contracted in darkness. After extirpation of the eyes the red and yellow chromatophores are maximally expanded independently of light and background, whereas the white ones, at least in half the number of the experimental animals, retain their full power of expansion and contraction. Thus on a dark background they do not contract as in animals that can see; the sole active factor which regulates their movement is light. Independently of the color of the background, the white chromatophores in eyeless animals expand at high and contract at low light intensity, as if they were a kind of "independent effectors" (Parker, '19) reacting directly to light. From its similar behavior, the white pigment of *Paratya compressa*, may also be an independent effector. It is highly reflecting and may be directly affected by light.

The fact that *Crangon* is able to adapt itself to backgrounds of different colors supports, according to Parker ('30), the theory that more than one hormone are concerned in the regulation of the pigment movements in shrimps. A hormone chiefly concerned with pigment concentration was found by Koller ('29, '30) in the eye-stalks of *Crangon*; Perkins ('28) detected the same hormone in the eye-stalks of *Palaemonetes*, and Koller has also made serveral experiments with the "black organs" in *Crangon*. Extracts of this organ, which is situated in the rostral region are said to expand the black and red pigments in this species. Beauvallet & Veil ('34) have confirmed the fact that the extracts of the rostral region cause expansion of the pigments in *Palaemon* (*Leander*) *squilla*, but they add, that an extremely high concentration is necesssary. Perkins & Snook ('31) and Kropp & Perkins ('33), on the contrary, were not able to verify the existence of a rostral black organ in the American species closely related to the European *Crangon vulgaris.* According to HANSTRÖM's investigation ('37) of American decapods, extracts of the rostral region of *Cambarus*, injected into *Palaemonetes vulgaris*, did not cause any expansion of the chromatophore. I could not find any effect of the extracts of this portion in *Paratya compressa.*

The red and yellow pigments of *Paratya* are expanded in the light on a black background, but concentrated on a white background. They are expanded when the eyes are not stimulated by light (i. e. at night, in darkness during the day, or after black-painting of the eyes). With the extirpation of the eyes in the decapod Natantia (shrimps, prawns) most investigatiors have found a darker color following the expansion of the red and yellow pigments (PARKER, BROWN & ODIORNE, '35; CARLSON, '36; WELSH, '37). It is also the case in *Paratya compressa,* which belongs to Natantia. The decapod Brachyura (the crabs), however, of which *Uca pugilator* has been most thoroughly investigated, behave in a quite different manner (MEGUŠAR, '12; CARLSON, '35, '36; ABRAMOWITZ, '36). Though other explanations may be possible, it may be assumed that the eye-stalk hormone or hormones which concentrates the red and yellow pigments in blinded *Paratya* as well as in *Palaemonetes,* causes the expansion of the black and red pigments in blinded *Uca.*

CARLSON has further shown that color change in Brachyura generally agrees in most details with that in *Uca.* After blinding by extirpation of the eyes, the yellow pigment in the crabs is dispersed, just like the yellow pigment in the shrimps. As ABRAMOWITZ ('37) remarks, however, the chemistry of the pigments in the Crustacea is little known, and a comparison of the chromatophore reactions on a chemical basis is at present impossible. He has further shown that no uniformity exists in the response of the various chromatophores in different crustaceans with respect to the anatomical features of these organs, whether monochromatic or polychromatic. ABRAMOWITZ refers to BROWN's concept of the existence of one contracting hormone for each pigment, the "multiple theory", based on the reaction of pigments in *Palaemonetes* in different backgrounds. According to ABRAMOWITZ, this theory requires the existence of a veritable array of hormones, and in contrast to it he presents "unitary theory". The latter theory aims at satisfactorily explaining the diversity of pigmentary reactions occurring among the decapods; according to it there is one common hormone whose effect on various dermal pigments is determined by the chromatophoral organizations of the species.

In discussing the finer mechanism of the pigment migrations, it is of importance to know which state, contraction or expansion, ought to be regarded as the state of rest or of activity of chromatophore. According to PARKER ('35), in the melanophores of fishes (*Fundulus*) neither of the states of pigment is necessarily a state of rest. The state of activity is associated with much brownian movement of the pigment granules, and the state of rest with very little of this movement; this fact according to PARKER suggests that the melanophore protoplasm has the character of a sol in the state of activity and the character of a gel in the state of rest. At any rate, the hormone in the eye-stalk must be the contracting substance produced through the action of light.

In my experiment on shrimps it can be emphasized that carbon dioxide gas induces the expansion of the chromatophores. This fact may be evidence that the expansion of the chromatophores is caused by unfavorable conditions. The fact that 'expantin' has not been found in the eye-stalks and that the extirpation of the eyes and fatal state of the animals induce the expansion of the chromatophore, may support the assumption that, in crustaceans, the expanded state of the chromatophore is the resting state.

PERKINS ('28) and KOLLER ('29, '30) made the first statements concerning the physico-chemical nature of the pigment activating hormone of decapods. They proved that this substance has a specific action, that it is conducted through the blood, is soluble in water, can be boiled without destruction, is neither species- nor group-specific, is still active after considerable dilution (at least 1 : 500,000) and is not spoiled by the action of the digestive enzymes. The eye-stalk can further be kept dry for a long time and still yield active extracts. CARLSON ('36) has shown that the pigmentary hormone in *Palaemonetes* passes through a cellophane membrane, that it is not soluble in ether but soluble in alcohol, and that it is rather stable, so that it can be boiled for a short time with diluted HCl and NaOH without losing its activity. Recently, ABRAMOWITZ ('40) reported about the chemical nature of this substance that the extracts of the eye-stalks of *Uca* reacted in a characteristic fashion for amino bases.

KOLLER and MEYER ('30), MEYER ('30, '31), PERKINS and KROPP ('32), KROPP and PERKINS ('33), and ABRAMOWITZ ('36) have all examined the action of the crustacean eye-stalk hormone on the chromatophores of vertebrates. Just as the intermedin of the vertebrate hypophysis is able to act upon the crustacean chromatophores, so the color change hormone of the crustaceans has an influence upon the chromatophores of vertebrates, but the papers of different authors conflict in certain respects; most of their works, however, agree in showing that the crustacean hormone causes expansion of amphibian chromatophores and contraction of fish chromatophores. The result of my experiment is consistent with this statement: the extracts of the eye-stalk of *Paratya compressa* produced the expansion of the melanophores of tadpoles (*Rana nigromaculata*) and the contraction of the melanophores of a teleostei (*Oryzias latypus*). Though the crustacean color change hormone agrees with the intermedin of vertebrates in certain respects, we can not identify these two hormones at present.

SUMMARY

1. *Paratya compressa* (DE HAAN) was used as the material for the investigation of color changes.

2. This animal changes its colouration in accordance with the color of the background. It becomes reddish brown on a dark background; pale and transparent on a light one.

3. The response to various colored backgrounds was investigated with regard to the four pigments of the chromatophores.

4. The number of the chromatophores distributed over the parts of the body was approximately estimated.

5. Absolute darkness brings about a complete contraction of the chromatophores regardless of the color of backgrounds. For the painting of the eyes a new method was devised.

6. The slight effect of temperature upon the chromatophore was observed in the red pigment.

7. Definite effects of ions upon the behavior of chromatophores were unrecognizable.

8. The effect of CO_2 upon the chromatophores was remarkable. Immersion in, or injection of CO_2, rapidly expands the chromatophores.

9. Removal of one eye has no effect upon the chromatophores, but extirpation of both the eyes brings on a lasting expansion which is unaffected by light or background.

10. The chromatophore index was proposed as a modification of the melanophore index of HOGBEN and SLOME. By means of this index it may be possible to indicate in a curve the time relation of various changes of the chromatophore.

11. An extract of the eye-stalks of white adapted *Paratya compressa*,

when injected into blinded animals brings about a concentration of the hitherto expanded chromatophores. Extract from shrimps adapted to stronger illumination induces a greater and longer lasting contraction.

12. An extract of the rostral parts of this shrimp effected no influence upon the chromatophore.

13. There is evidence to support the statement that endocrine organs producing a substance, which is carried to the chromatophores by the blood stream, and thus bring about a contraction of the chromatophores, are localized in the eye-stalks.

14. The eye-stalk hormone of *Paratya compressa* is effective on the vertebrate color system.

LITERATURE

Abramowitz, A. A. (1935). Color changes in cancroid crabs of Bermuda. Proc. nat. Acad. Sci., Vol. 21, 677–681.

Abramowitz, A. A. (1936). Action of crustacean eye-stalk extract on melanophores of hypophysectomized fishes, amphibians and reptiles. Proc. Soc. exp. Biol. Med., Vol. 34, 714–716.

Abramowitz, A. A. (1936). The action of intermedin on crustacean melanophores and of the crustacean hormone on elasmobranch melanophores. Proc. nat. Acad. Sci., Vol. 22, 521–523.

Abramowitz, A. A. (1937). The comparative physiology of pigmentary responses in the crustacea. J. exp. Zool., Vol. 76, 407–422.

Abramowitz, A. A. (1937). The chromatophorotropic hormone of the Crustacea: Standardization, properties and physiology of the eye-stalk glands. Biol. Bull., Vol. 72, 344–366.

Abramowitz, A. A. (1938). The similarity between the hypophyseal chromatophorotropic hormone of the crustacean eye-stalk. Physiol. Zool., Vol. 11, 299–310.

Abramowitz, A. A. (1940). Purification of the chromatophorotropic hormone of the crustacean eye-stalk. J. Biol. Chem., Vol. 132, 501–506.

Abramowitz, A. A. and R. K. Abramowitz (1938). On the specificity and related properties of the crustacean chormatophorotropic hormone. Biol. Bull., Vol. 74, 278–296.

Abramowitz, R. K. and A. A. Abramowitz (1940). Moulting, growth, and survival after eye-stalk removal in *Uca pugilator*. Biol. Bull., Vol. 78, 179–188.

Atkins, D. (1926). On nocturnal color change in the pea-crab (*Pinnotheres veterum*). Nature, Vol. 117.

Bauer, V. and E. Degner (1913). Über die allgemein-physiologische Grundlage des Farbwechsels bei dekapoden Krebsen. Zeit. allg. Physiol., Bd. 15, 363–412.

Beauvellet, M. et C. Veil (1934). Chromatophores de poisson et chromatophores de crustacés. C. r. Soc. Biol., Tom. 117, 688–690.

Brown, F. A. (1933). The controlling mechanism of chromatophores in *Palaemonetes*. Proc. nat. Acad. Sci., Vol. 19, 327–329.

Brown, F. A. (1934). The chemical nature of the pigments and the transformations responsible for color changes in *Palaemonetes*. Biol. Bull., Vol. 67, 365–380.

Brown, F. A. (1935). Control of pigment migration within the chromatophores of *Palaemonetes vulgaris.* J. exp. Zool., Vol. 71, 1–14.

Brown, F. A. (1935). Color change in *Palaemonetes.* J. Morph. and Physiol., Vol. 57, 317–333.

Brown, F. A. (1938). An internal secretion affecting viability in Crustacea. Proc. nat. Acad. Sci., Vol. 24, 551–555.

Brown, F. A. (1939). Extrachromatophoric activities of the sinus gland of *Palaemonetes vulgaris.* Anat. Rec., Vol. 75, 129.

Brown, F. A. (1939). The source of chromatophorotropic hormones in crustacean eye-stalks. (Abstract) Biol. Bull., Vol. 77, 329.

Brown, F. A. and O. Cunningham (1939). Influence of the sinus gland of crustaceans on normal viability and ecdysis. Biol. Bull., Vol. 77, 104–114.

Brown, F. A. and H. E. Ederstrom (1939). On the control of the dark chromatophores of *Crago* telson and uropods. (Abstract) Biol. Bull., Vol. 77, 330,

Brown, F. A. and H. H. Scudamore (1940). Differentiation of two principles from the crustacean sinus gland. J. cell. and comp. physiol., Vol. 15, 103–119.

Carlson, S. Ph. (1935). The color changes in *Uca pugilator.* Proc. nat. Acad. Sci., Vol. 21, 549–551.

Darby, H. H. (1938). Moulting in the crustacean, *Crangon armillatus.* Anat. Rec., Vol. 72, 78.

Degner, E. (1912). Über Bau und Funktion der Krusterchromatophoren. Z. wiss. Zool., Bd. 102, 1–78.

Degner, E. (1912). Weitere Beiträge zur Kenntnis der Crustaceenchromatophoren. Z. wiss. Zool., Bd. 102, 701–710.

Franz, V. (1910). Zur Struktur der Chromatophoren bei Crustaceen. Biol. Cbl., Bd. 30, 150–158.

Fröhlich, A. (1910). Farbwechselreaktion bei *Palaemon.* Arch. Entw.-Mech. Organ., Bd. 29, 432–438.

Gamble, F. W. (1910). The relation between light and pigment formation in *Crenolobius* and *Hippolyte.* Quart. J. Micr. Sci., Vol. 55, 541–583.

Gamble, F. W. and F. W. Keeble (1910). *Hippolyte varians:* a study in colour change. Quart. J. Micr. Sci., Vol. 43, 589–698.

Giersberg, H. (1934). Physiologie des Farbwechsels bei Tieren. Zool. Anz., Suppl., Bd. 7, 96–126.

Hanström, B. (1935). Preliminary report on the probable connection between the blood gland and the chromatophore activator in decapod crustaceans. Proc. nat. Acad. Sci., Vol. 21, 584.

Hanström, B. (1937). Inkretorische Organe und Hormonfunktionen bei den Wirbellosen. Erg. Biol., Bd. 14, 143–224.

Hanström, B. (1939). Hormones in inverterbrates. pp. 198. Oxford.

Hitchcock, H. B. (1941). The coloration and color change of the Gulf-weed crab *Palaneo minutus.* Biol. Bull., Vol. 80, 26–30.

Hogben, L. T. (1924). The pigmentary effector system. pp. 152. Edinburgh and London.

Hosoi, T. (1934). Chromatophore-activating substance in the shrimps. J. Fac. Sci. Tokyo Imp. Univ., Vol. 3, 265–270.

Kalmus, H. (1938). Über einen latenten physiologischen Farbwechsel beim Flusskrebs *Potamobius astacus,* sowie seine hormonale Beeinflussung. Z. f. vergl. Physiol., Bd. 25, 494–508.

KEEBLE, F. and F. W. GAMBLE (1904). The color-physiology of higher Crustacea. Phil. Trans. London, Vol. 196, 295-388.

KEEBLE, F. and F. W. GAMBLE (1904). On the presence of mobile fat in the chromatophores of Crustacea. Zool. Anz., Bd. 27, 262.

KLEINHOLZ, L. H. (1938). Studies in the pigmentary system of crustacea. IV. The unitary versus the multiple hormone hypothesis of control. Biol. Bull., Vol. 75, 510-532.

KLEINHOLZ, L. H. and J. H. WELSH (1937). Colour changes in *Hippolyte varians*. Nature, Vol. 140.

KOLLER, G. (1925). Über Farbwechsel bei *Crangon vulgaris*. Verh. dtsch. Zool. Ges., Bd. 30. 128-132.

KOLLER, G. (1927). Über Chromatophorensystem, Farbensinn und Farbwechsel bei *Crangon vulgaris*. Z. vergl. Physiol., Bd. 5, 191-246.

KOLLER, G. (1928). Versuche über die inkretorischen Vorgänge beim Garneelenfarbwechsel. Z. vergl. Physiol., Bd. 8, 601-612.

KOLLER, G. (1929). Die innere Sekretion bei wirbellosen Tieren. Biol. Rev., Bd. 4, 269-306.

KOLLER, G. (1930). Weitere Untersuchungen über Farbwechsel und Farbwechsel-hormone bei *Crangon vulgaris*. Z. vergl. Physiol., Bd. 12, 632-667.

KOLLER, G. (1938). Hormone bei wirbellosen Tieren. SS. 143. Leipzig.

KOLLER, G. und E. MEYER (1930). Versuche über den Wirkungsbereich von Farbwechselhormonen. Biol. Zbl., Bd. 50, 759-768.

KROPP, B. (1932). The crustacean chromatophore activator and the gonads of the rat. Proc. nat. Acad. Sci., Vol. 18, 690.

KROPP, B. and W. J. CROZIER (1934). The production of the crustacean chromatophore activator. Proc. nat. Acad. Sci., Vol. 20, 453-456.

KROPP, B. and E. B. PERKINS (1933). The occurrence of the humoral chromatophore activator among marine crustaceans. Biol. Bull., Vol. 64, 28-32.

KROPP, B. and E. B. PERKINS (1933). The action of the crustacean chromatophore activator on the melanophores of fishes and amphibians. Biol. Bull., Vol. 64, 226-232.

LEHMANN, C. (1923). Fabwechsel bei *Hyperia galba*. Biol. Zbl., Bd. 43, 173-175.

LELU, P. (1938). Les corrélations humorales chez les invertébrés. pp. 80. Paris.

MEGUŠAR, F. (1912). Experiments über den Farbwechsel der Crustaceén. Arch. Entw.-Mech. Organ., Bd. 33, 462-665.

MENKE, H. (1911). Periodische Bewegungen und ihr Zusammenhang mit Licht und Stoffwechsel. Pflügers Arch., Bd. 140, 37-91.

NAVEZ, A. E. and B. KROPP (1935). The growth-promoting action of crustacean eye-stalk extract. Biol. Bull., Vol. 67, 250-258.

PARKER, G. H. (1932). Humoral agents in nervous activity. pp. 79. Cambridge Univ. Press.

PARKER, G. H. (1935). What are the resting and the active states of chromatophores? Proc. nat. Acad. Sci., Vol. 21, 286-292.

PAEKER, G. H. (1936). Color changes of animals in relation to nervous activity. pp. 71. Philadelphia.

PERKINS, E. B. (1928). Color changes in crustaceans, especially in *Palaemonetes*. J. exp. Zool., Vol. 50, 71-105.

PERKINS, E. B. and T. SNOOK (1931). Control of pigment Migration in the chromatophores of crustaceans. Proc. nat. Acad. Sci., Vol. 17, 282-285.

PERKINS, E. B. and T. SNOOK (1932). The movement of pigment within the chromatophores of *Palaemonetes*. J. exp. Zool., Vol. 61, 115-128.

SCHLIEPER, C. (1926). Der Farbwechsel von *Hyperia galba.* Z. vergl. Physiol., Bd. 3, 547–557.

SMITH, D. C. (1930). The effects of temperature changes upon the chromatophores of crustaceans. Biol. Bull., Vol. 58, 193–202.

STÅHL, F. (1938). Preliminary report on the color changes and in the incretory organs in the heads of some crustaceans. Archiv. for Zool., Bd. 30, 1–3.

STEPHENSON. (1932). Control of chromatophores in *Leander serratus.* Nature, Vol. 133.

WRIGHT, W. O. (1934). The measurement and analysis of colour adaptation phenomena. Proc. Roy. Soc. London. Ser. B., Vol. 115, 49–87.

STUDIES ON FRESHWATER BRYOZOA OF JAPAN. V
THE VARIATIONS OCCURRING IN THE STATOBLASTS AND IN THE NUMBER OF THE TENTACLES OF *CRISTATELLA MUCEDO* CUVIER

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In *Cristatella mucedo* CUVIER there is a great deal of variation in the diameter of the statoblasts, the number of spines on the same, and in the number of tentacles. Concerning classification on this basis, different views are held by various writers. Some consider such variations as common to the whole species while others use them as means to distinguish varieties of the species.

The present report has attempted to deal with the variations occurring in the statoblasts as well as in the number of the tentacles of *C. mucedo*, using the materials collected from various localities distributed in the Tôhoku and Tyûbu districts of Japan.

Before proceeding further, the writer would like to express his hearty thanks to Professor SANJI HÔZAWA who has kindly helped him in many ways during the course of the present study.

In Japan, *Cristatella mucedo* has hither-to been found in the following localities, viz. Karahuto (South Sagalin), where some statoblasts only were collected by D. MIYAJI, and were reported on by him in 1934; Tisima (Yambetu-numa), where some statoblasts only were obtained by AKAMARO TANAKA (Viscount), and reported on by HÔZAWA in 1938; Hokkaido, where some statoblasts only were collected by the present writer; the Tôhoku district of Honsyû where colonies and some statoblasts were collected by the writer, and reported on by HÔZAWA in 1938; and in the Tyûbu district (Syôzin-ko in Yamanasi-ken) of Honsyû, where colonies (almost degenerated) and some statoblasts were obtained by N. SASAKI in 1936, and reported on by the writer in 1942.

The materials treated in the present report, are those taken from 9 ponds distributed in 4 localities, viz. 1) 6 ponds in Sendai; 2) Kase-numa in Siogama; 3) Ezogatate-no-tameike near Aomori; 4) Syôzin-ko in Yamanasi-ken.

The Variations occurring in the Statoblasts

With regard to the statoblasts, variations are recognized in the number of spines and in the diameters and the results thus far measured are shown in Table I.

As is seen in Table 1, in all of the 28 materials, the diameter of the statoblasts varies widely as BRAEM wrote in 1889, the range being 1.04 mm in maximum and 0.75 mm in minimum. In the spines of the same, the number varies a great deal, being 32 in maximum and 0 in minimum when observed on the so-called dorsal face, while on the socalled ventral they are 65 in maximum and 20 in minimum.

Owing to the wide range of variation in the number of spines, when a few of the materials are compared with one another, it seems as if they are not from one species. But if the variations occurring in many specimens, obtained in one locality in various seasons, are examined, it becomes clear that they are merely a seasonal occurrence in the one species.

As it is obvious from the Table, the range of the variation of the dorsal spines is very wide.

Judging from the materials obtained from the various localities it may be safely stated that when the temperature of the water in the pond becomes lower, the diameter of the statoblasts seems to become smaller, and the number of spines also seems to become fewer, the dorsal spines especially decreasing very much.

KRAEPELIN has distinguished two varieties of *idae* and *genuina* of the species *C. mucedo*, basing their characteristics upon the number of spines and the diameter of the statoblasts as mentioded below.

	Diameter of Statoblasts	Number of Spines	
		dorsal face	ventral face
C. mucedo var. *idae*	1.00–1.25 mm	20–34	38–50
gunuina	0.7–0.97 mm	10–22	20–37

Some of the Japanese materials (Nos. 2, 3, 4, 9, 10, 14, 15, 21, 24, 25) seem to show some features intermediate between KRAEPELIN's two varieties and thus it suggests that the classification proposed by KRAEPELIN is not appropriate. From the local and seasonal variations occurring among the Japanese materials as shown in Table I, it may be proved that some

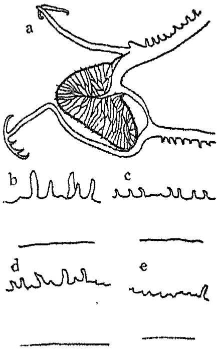
TABLE I.

Localities	Date	No	Diameter in mm							Number of Spines						
			Whole			Capsule			Number of readings	Dorsal face			Venttal face			Number of readings
			Max.	Min.	Mean	Max.	Min.	Mean		Max.	Min.	Mean	Max.	Min.	Mean	
A small pond (I) in Sendai	VI, 19, 1941	1	1.02	0.90	0.936	0.76	0.70	0.739	41	21	11	16.45	44	31	37.64	42
	VII, 13,	2	0.98	0.88	0.921	0.80	0.70	0.728	68	26	13	18.48	44	34	39.26	64
	VII, 30,	3	0.94	0.86	0.907	0.76	0.66	0.715	57	22	10	16.05	55	31	40.25	56
	VIII, 13,	4	0.96	0.86	0.910	0.78	0.66	0.727	61	24	10	17.19	51	30	40.27	58
	XI, 1,	5	0.92	0.84	0.871	0.78	0.72	0.756	64	9	1	4.88	42	30	35.45	60
	XII, 5,	6	0.92	0.78	0.840	0.76	0.64	0.713	86	9	0	1.93	41	25	31.89	149
	VI, 14, 1940	7	0.90	0.80	0.850	0.70	0.60	0.640	51	23	15	18.06	50	35	42.35	48
	X, 28,	8	0.96	0.80	0.870	0.78	0.66	0.710	78	16	6	11.15	45	26	33.83	78
A small pond (II) in Sendai	VII, 3, 1941	9	1.00	0.92	0.975	0.82	0.70	0.738	52	26	9	18.35	50	32	41.93	60
	VIII, 30,	10	1.04	0.90	0.980	0.82	0.68	0.748	56	29	13	19.04	57	32	41.66	62
	XI, 1,	11	1.00	0.90	0.944	0.84	0.70	0.762	54	15	1	6.03	43	26	33.70	70
	XII, 5,	12	0.96	0.80	0.868	0.80	0.70	0.745	55	9	0	2.00	36	23	27.78	61
	X, 26, 1940	13	0.98	0.86	0.920	0.80	..70	0.750	83	15	5	9.92	40	29	34.28	82
Anyôdi-numa in Sendai	VIII, 9, 1941	14	0.96	0.90	0.918	0.72	0.66	0.692	55	25	16	20.91	51	34	42.15	67
	VII, 23, 1938	15	0.94	0.84	0.890	0.72	0.62	0.670	57	27	19	23.25	65	38	50.50	53
	VI, 6, 1940	16	0.85	0.75	0.780	0.65	0.57	0.610	54	26	12	17.66	43	29	36.49	145
Kaidô-numa in Sendai	VII, 28, 1941	17	1.02	0.90	0.945	0.78	0.68	0.728	62	18	7	13.60	38	28	33.39	61
	VIII, 12,	18	0.96	0.84	0.893	0.76	0.64	0.702	26	20	9	15.56	41	28	32.52	26
	VIII, 14,	19	0.98	0.84	0.903	0.76	0.66	0.700	53	22	6	16.37	44	26	34.73	67
	XI, 30,	20	0.98	0.84	0.889	0.78	0.70	0.720	62	12	0	4.60	48	26	33.88	60
Kase-numa in Siogama	VI, 27, 1941	21	0.92	0.84	0.892	0.72	0.66	0.681	58	21	9	18.08	46	32	38.84	82
	X, 30,	22	0.96	0.84	0.891	0.74	0.66	0.690	57	21	6	12.70	43	29	34.64	64
	XI, 12,	23	0.92	0.80	0.864	0.72	0.64	0.693	58	16	1	8.70	38	20	31.45	72
Udo-numa in Sendai	VI, 23, 1941	24	0.98	0.88	0.930	0.78	0.68	0.715	61	23	14	18.64	52	32	41.93	75
	VII, 4,	25	0.96	0.86	0.924	0.76	0.68	0.719	59	27	15	21.33	51	33	41.54	65
A small pond near Sendai	VIII, 5, 1941	26	0.98	0.88	0.935	0.74	0.68	0.717	58	27	16	20.15	52	33	42.01	66
Ezogatate-no-tameike	VII, 16, 1939	27	0.88	0.82	0.840	0.70	0.60	0.640	83	32	21	26.09	49	33	41.76	83
Syôdin-ko	XII, 1, 1935	28	0.88	0.76	0.813	0.74	0.64	0.683	76	13	0	5.02	32	20	26.61	78

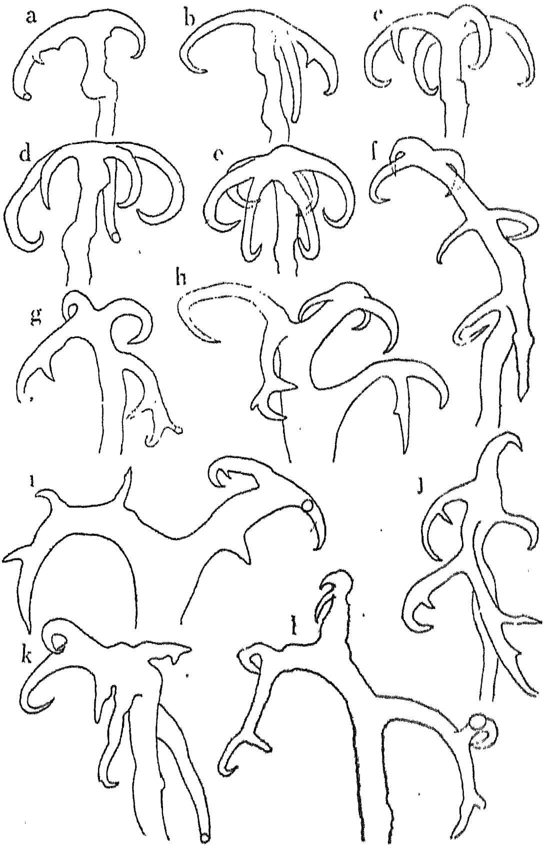
species and varieties of the present genus described by other writers must be regarded as the result of their having treated these variations as distinguishing characteristics.

The materials Nos. 15 and 16 were obtained by the present writer in 1938 and 1940 from the same pond, and he considers that these two must be of the same strain, though some disparity may be noticed in the number of spines.

In the materials above mentioned the structure of the capsule (text-fig. 1) is alike in all, being entirely similar to that of *C. lacustris*, a species which was first described by POTTS in 1884. The spinous papillae of the capsule are of almost the same height when observed in the central part and on the margin of the capsule (text-fig. 1. b, c), but in some material those found in the central part are shorter than those on the margin (text-fig. 1. d, e).



Text-fig. 1. Cross section through the center of a statoblast of *C. mucedo*.
a, annulus ×90 b–e, surface of the capsule ×260 b, d, marginal (circumferential) part of the capsule c, e, central part of the same

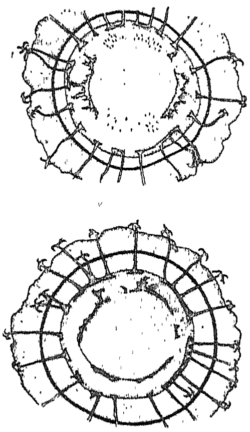


Text-fig. 2. Hooks of the statoblasts of *C. mucedo*. ×400

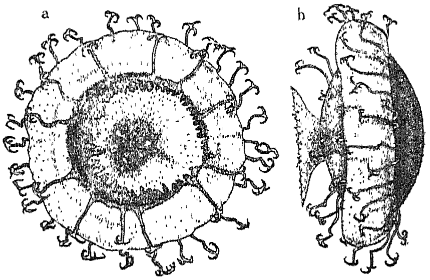
In all the materials at hand, the hooks found on the spines vary in number from 2 to 6 (text-fig. 2. a–e).

Sometimes a number of small accessory hooks are also seen on each of the primary hooks (text-fig. 2. a–c), and the primary hooks often look very irregular in shape (text-fig. 2. f–l).

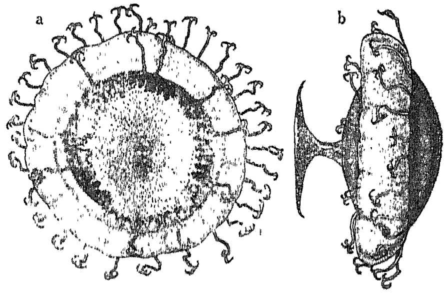
The writer would like to append here an article on some very peculiarly formed statoblasts (text-figs. 3–6). Each of these malformed statoblasts bears on the dorsal face of the capsule a number of thin ridges so arranged as to form either an entire (text-figs. 4, 5) or an incomplete circle (text-fig. 3). In only one case of malformed statoblasts were these ridges seen on both the dorsal and ventral faces (text-fig. 6). Sometimes these ridges are combined to form a funnel-like structure (text-fig. 5). These ridges have their outer free edges serrated rather irregularly and have a number of minute spines on



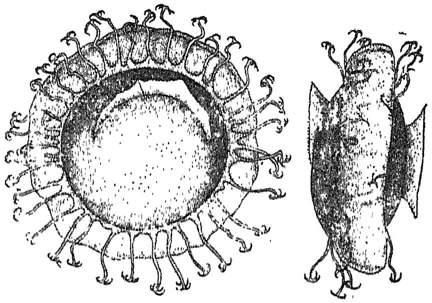
Text-fig. 3. Two malformed statoblasts of *C. mucedo.* ×50



Text-fig. 4. Two malformed statoblasts of *C. mucedo.* ×50 a, so-called dorsal view b, side view



Text-fig. 5. Two malformed statoblasts of *C. mucedo.* ×50 a, dorsal view b, side view



Text-fig. 6. One malformed statoblasts of *C. mucedo.* ×50 a, ventral view b, side view Only this statoblasts has two ridges on both faces.

the whole surface. Such malformed statoblasts are met rather rarely and the materials that produced these malformed statoblasts are shown in Table II.

TABLE II.

Localities	Date	Normal	Malformed
A small pond I in Sendai	VI, 22-VII, 4, 1941* VI, 22-VII, 13, 1941	493 74	49 5
A small pond II in Sendai	XI, 1, 1941	70	1
Kaidô-numa	VII, 28-VIII, 12, 1941	29	13
Kase-numa	X, 30, 1941 X, 30 XI, 12, 1941	64 72	1 1
Udo-numa	VI, 23-VII, 4, 1941	309	53

*collected on VI, 22 and was cultured in a small pond of Biological Institute untill VII, 4.

The cause of the formation of such malformed statoblasts may possibly be attributed to the high temperature of the water.

The Variation in the Number of Tentacles

The number of tentacles varies in a wide range. The tentacles of the polypides from the central part (1st and 2nd series) of some zoaria were counted and the results are shown in Table III.

TABLE III.

Localities	Date	No.	Max.	Min.	Mean	Number of readings	Zoaria
A small pond in Sendai	VI, 9, 1941	1	91	76	84.00	50	2
	VI, 19,	2	93	81	87.93	50	4
	VII, 30,	3	89	82	85.62	50	4
	XI, 1,	4	88	75	82.98	50	5
	XII, 5,	5	76	55	67.02	50	3
	VI, 14, 1940	6	90	81	84.10	50	3
	X, 28,	7	82	61	69.68	60	4
A small pond in Sendai	VII, 3, 1941	8	92	76	84.50	50	3
	VII, 30,	9	99	83	91.50	50	4
	XI, 1,	10	91	80	86.78	50	4
	X, 26, 1940	11	82	68	75.42	50	4
Kase-numa	VI, 27, 1941	12	93	80	85.56	50	4
	X, 30,	13	90	78	85.24	50	4
	VI, 21, 1939	14	81	71	77.19	26	2

As is seen from Table III the number of tentacles ranges rather widely, being 99 in maximum and 55 in minimum.

This shows clearly that the number of tentacles must not be treated as a constant feature in the classification of *Cristatella mucedo*.

LITELATURE

ALLMAN, G. J. (1856). Monogragh of Fresh-water Polyzoa.

BRAEM, F. (1890). Untersuchungen über die Bryozoen des süssan Wassers. Bibliotheca Zoologica, Bd. II, Heft VI.

DAVENPORT, C. B. (1904). Report on the Fresh-water Bryozoa of the United States. Proc. U. S. Nat. Mus., Vol. 27, pp. 211–221.

HÔZAWA, S. (1939). *Cristatella mucedo* CUVIER found in Japan. A Report which was made on the 14th Annual Meeting of Zoological Society of Japan of 1938 and was published in the Zoological Magazine, Vol. 51, No. 2, p. 104.

JULLIEN, J. (1885). Monographie des Bryozoaires d'eau Douce. Bull. Soc. Zool. de France, 10: 119 pp.

KRAEPELIN, K. (1887). Die deutschen Süsswasser-Bryozoen.

MIYAJI, D. (1934). Karahuto nite Hakken sitaru Tansui-Kokemusi *Cristatella* no Kyûga. (On the statoblasts of Fresh-water Polyzoa, *Cristatella*, found in South Sagalin.) Botany and Zoology, Vol. 3, No. 5, p. 125.

POTTS, E. (1884). On a supposed new Species of *Cristatella*. Proc. Acad. Nat. Sci. Philadelphia, 1884, pp. 193–199.

ROGICK, M. D. (1935). Studies on Freshwater Bryozoa. II, The Bryozoa of Lake Erie. Trans. Amer. Micro. Soc., 54 (3), pp. 245–263.

ROGICK, M. D. (1937). V. Some Addition to Canadian Fauna. Ohio Jour. Sci., Vol. XXXVII, No. 2, pp. 99–104.

SCHACHANOWSKAJA, M. (1930). Über Vorkommen und Systematik von *Cristatella mucedo* in Böhmen. Zool. Jahrb. Abt. Syst. Ökol. Geogr. Tiere, 59, pp. 351–362.

TORIUMI, M. (1941). Studies on Freshwater Bryozoa of Japan. I, Sci. Rep. Tôhoku Imp. Univ. Ser. 4, Vol. XVI, No. 2, pp. 193–215.

TORIUMI, M. (1942). Syôzin-ko nite eta Ayumikokemusi, *Cristatella mucedo*. (*Cristatella mucedo* obtained in Syôzin-ko.) Botany and Zoology. Vol. 10, No. 2, p. 178.

ECOLOGICAL NOTES ON THE ACTIVITIES OF SOME INSECTS COMING TO THE FLOWERS OF "YATUDE", *FATSIA JAPONICA*, WITH SPECIAL REFERENCE TO THE ECOLOGICAL IMPORTANCE OF THE SOLAR RADIANT ENERGY

(DIURNAL RHYTHM OF ACTIVITIES IN INSECTS AND ITS ENVIRONMENTAL CONDITIONS. NO. XII)

By

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(With 6 Text-figures)

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INTRODUCTIONS

In Sendai "Yatude", *Fatsia japonica*, blooms during the season extending from the middle of November to the middle of December. In that season the air temperature is almost below 10°C even in the daytime, and when the morning is fine it often frosts and freezes. The environmental conditions seem, therefore, to be rather unfavourable for the active life of insects. Nevertheless we can notice fairly a large number of insects visiting the flowers of *Fatsia japonica.* The writer was able to collect about 13 species of the insects. They are *Eristalomya tenax*, *Megaspis zonata*, *Eristalis cerealis*, *Sphaerophoria menthastri*, *Obliosyrphus sapporensis*, *Syrphus serarius*, *Calliphola lata*, *Lucilia jedona*, *Musca domestica*, *Vespula lewisii* and *Elasmostethus humeralis*, etc. Among these, *Eristalomya tenax* and *Calliphala lata* are overwhelmingly great in number, and *Vespula lewisii* looks peculiar in the behavoir of nectar cropping.

In order to investigate the diurnal activities of insects in early winter, the writer observed the activities of the insects which come to the flowers of *Fatsia japonica*, mainly of *Eristalomya tenax*, *Calliphola lata* and *Vespula lewisii.*

The "Yatude", of which the present observation was done, stands in the botanical garden of the Biological Institute of the Tôhoku Imperial University and close to the lecture room of the Institute (Fig. 1). In the afternoon the sun, shaded by the building of the lecture room, does not shine directly upon the "Yatude". Two pancicles were selected to observe the insects visiting their flowers.

The air temperature and the humidity were measured by ASSMANN's Psychrometer. The solar radiant heat being taken into consideration, a black heliothermometer was used. The illuminating intensity was measured by MATUDA's illuminometer. Both the amount and classes of clouds were measured with the naked eye. The wind intensity was also measured with the nacked eye and was divided into 7 classes.

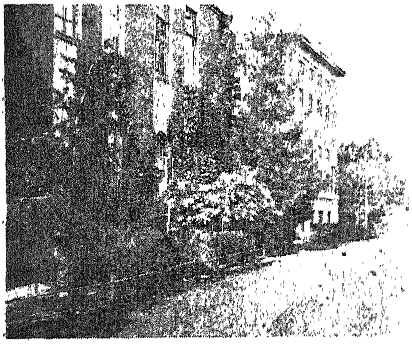

Fig. 1. The "Yatude", *Fatsia japonica*, and its surrounding, where the present investigation was done.

Before proceeding further, the writer wishes to express his gratitude to Prof. Dr. SANJI HÔZAWA for the continuous guidance and the kind encouragement and also to Assist. Prof. Dr. ISAO MOTOMURA for the valuable suggestions given to him. The writer is also grateful to Mr. KICHIMASA HASEGAWA for his kind assistance made to him during the cource of the present investigation. An acknowledgment is due to the Foundation for Promotion of Industrial and Scientific Research in Japan for the financial help given to the writer.

THE ACTIVITIES OF THE INSECTS AND THE ENVIROMENTAL CONDITIONS

I. The 6th day of December (Fig. 2): At 8th hour in the morning the weather was fairly favourable for the activities of *Eristalomya* and *Calliphola*, and thus their normal activities of the nectar cropping were seen till about 12th hour. Thereafter the said activities were weakened steadily, but of *Vespula* it was continuously active till

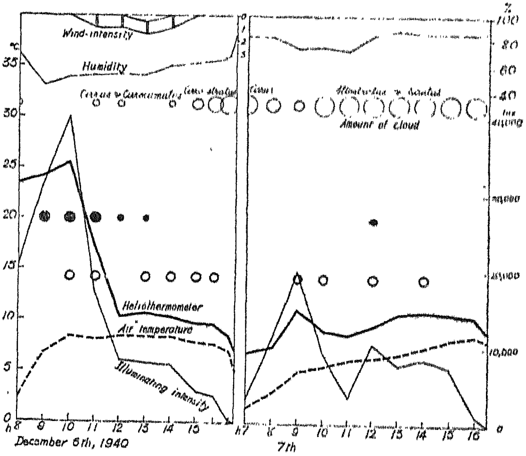

Fig. 2. Activities of insects and the environmental conditions, No. 1. The activities are represented according to the size of the rounded mark (black mark: *Eristalomya* and *Calliphola*, white mark: *Vespula*).

15th hour 45 min.

II. The 7th day of December (Fig. 2): At sunrise, it was very fine, but it became cloudy thereafter and even the misty rain was often seen. The activities of most insects could hardly be observed all day, but the flight and the act of nectar cropping of *Vespula* were observed during the time covering from 9th to 14th hour.

III. The 12th day of December (Fig. 3): Any flying insects were not observed in the morning, as the sun was covered by clouds and moreover it was fairly cold. When the sun began to shine at about 10th hour the flies became active. After the "Yatude" was shaded by the said building of the lecture room about at noon, their activities were suddenly weakened. Only *Vespula* was seen capable to fly even at about 14th hour. As *Calliphola* has generally a tendency to become active earlier than *Eristalomya* in the morning and is continuously active till late in the evening, it may be concluded that the resistance to the low temperature is stronger in the case of the former insect than in the case of the latter.

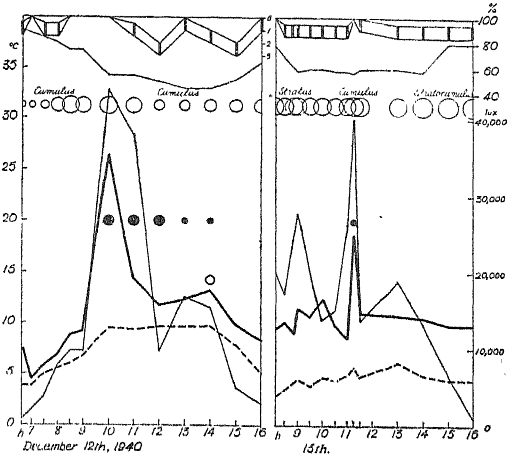

Fig. 3. Activities of insects and the environmental conditions, No. 2.

IV. The 13th day of December (Fig. 3): In the morning it was cloudy and often snowed a little, and thus no active insect was seen. At about 11th hour the clouds became breaking and the sun began to shine. At that time one *Eristalomya*, that has been resting in the neighbourhood of a panicle from the previous evening, flew away and one *Calliphola* came. Soon after, the "Yatude" was shaded from the sun.

V. The 15th day of December (Fig. 4): On the 14th day of December it snowed from morning to evening and the air temperature was lower than the freezing point and the snow has fallen on the ground to a thickness of about 15 cm. But it was very fine on the following 15th day. As it might be very interesting to see the activities shown by the insects after the snowfall, some observations were done from the morning of the

15th day. The air temperature was below 5°C even in the sunshine. At 9th hour 10 min., when the air temperature was 4.5°C and the reading of the heliothermometer was 26.1°C, the first flying *Eristalomya* was observed, and thereafter till about 10th hour the active nectar cropping and flight were seen around the panicle which jected amongst the snow (Fig. 5 & 6).

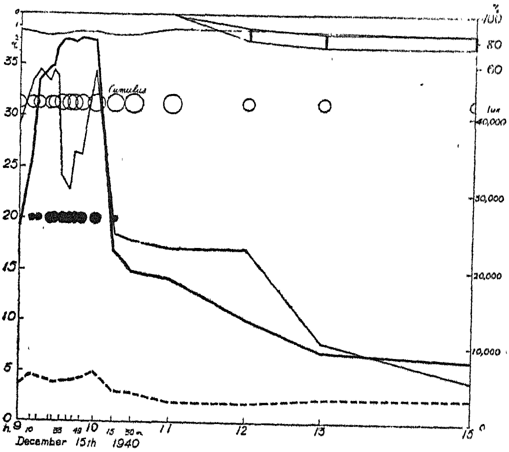

Fig. 4. Activities of insects and the environmental conditions, No. 3.

Fig. 5. The "Yatude" photographed at 9th hour of the morning on the 15th day of December. After 10 minutes of this time the first *Eristalomya* came to the flower.

Fig. 6. The "Yatude" photographed at 10th hour of the morning on the 15th day of December. The active acts of nectar cropping and flight of the flies were seen on the panicles of the "Yatude".

VI. The observations made are those mentioned above. Now the relations between the activities of the insects and the environmental conditions must be consulted. In the following the writer intended to inquire of the activities of *Eristalomya* and *Calliphola*, except for those of *Vespula*, because they seem to be somewhat peculiar in nature and thus they may be specially treated.

1) It is recognized from the Figs. 2, 3 & 4 that the air temperature seems scarcely to correlate with the activities of the insects. When the air temperature was only 3.8–4.8°C on the 15th of December, the active nectar cropping and flight were seen during the time extending from 9th hour to 10th hour. Judging from the air temperature mentiond above,

it seems to be expected that the insects may be active on the 6th and 7th days, and also that even on the 13th the active insects must be observed in the daytime. But it was not the case. Thus it is thought that some other factors may exist.

2) The parallerism was not recognized between the illuminating intensity and the activities of the insects. The active insects were observed in the afternoon of the 6th and 12th days when the illuminating intensity was below 15,000 lux. Accordingly, the active insects were expected to be seen during the time extending from 10th to 12th hour of the 15th day, in the beforenoon of the 13th day and in the morning of the 7th day, because the illuminating intensity was stronger than 15,000 lux. But they did not appear during those times mentioned above.

THE ACTIVITIES OF *CALLIPHOLA* IN THE DARKNESS

In order to decide whether the illuminating intensity is one of the most important factors influencing the said activities or not, it is necessary to investigate the activities of the said insects in the darkness. Of this problem some notes were taken in the case of *Calliphola*.

1) A number of flies were confined in a dark box cooled at the air temperature of about 1°C, and then they were kept at 3°C for about 20 minutes. Being thus treated, the flies became all motionless. The box was warmed gradually and then the air temperature was kept at about 18°C for 60 minutes. When the box was opened on a table illuminated at about 200 lux, the flies all flew away from the box. The same phenomenon was also observed when the box was opened in a dark room. At that time the traces of crawling made by the flies were obtained by placing a smoked paper within the box.

2) An interesting result was obtained from the observation made in the room warmed by a stove during the night. In that room the air temperature was 10–14°C during the daytime extending from 10th to 16th hour and it was fluctuated from 16 to 23°C during the night covering from 16th to 10th hour of the next morning. The flies in that room were scarcely active in the daytime, but they made some active flight in the night. The illuminating intensity in that room was very weak during the night, being only about 40 lux in the distance of one meter from an electric light. From the facts mentioned above, we are able to learn that the normal activities of the flies can be seen even in the environment

weakly illuminated and also that they are active even in the darkness if the temperature environment is favourable.

THE ACTIVITIES OF *ERISTALOMYA* AND *CALLIPHOLA* IN THE SLOWLY RISING TEMPERATURE ENVIRONMENT

The temperature limits of various stages of the activities were investigated in the laboratory experiment. The experiment was executed adopting the MOTOMURA's method (MOTOMURA, 1938)*. Next to the cooling, the temperature was allowed to rise at the rate of 1°C every 4 minutes.

CALLIPHOLA: At about 5–7°C the cleaning movement was observed. The crawling was seen at 8–10°C and the normal activity was noted at 12–15°C.

ELISTALOMYA: The temperature limits of various stages of the activities were a little higher, than in the case of *Calliphola*. The cleaning movement was observed at above 8°C and the crawling was at above 12°C. Just at 15°C the normal activity was seen.

ON THE ECOLOGICAL IMPORTANCE OF THE SOLAR RADIANT HEAT

In the course of the present observation which was made on the activities of the insects that came to the flowers of the "Yatude", the environmental air temperature never reached 10°C. From the laboratory experiment it was known that the flies, *Eristalomya* and *Calliphola*, never became active in such a low temperature environment as was mentioned above. Nevetheless the active flight and nectar cropping are really seen in such a low temperature environment in the field condition. For instance, the normal act of nectar cropping was observed on the 15th day of December, even when the air temperature was lower than 5°C. The fact mentioned above seems to be understand only when the influence of the solar radiant heat exerted upon the insect body, namely the absorption of the solar radiant heat must be taken into consideration. It seems to be permissible to think that the body temperature of the insects rises above the air temperature by the absorption of the solar radiant heat when they are exposed to the sunshine, and therefore the vigorous activities were induced notwithstanding the low air temperature. This fact was not proved directly by measuring the body temperature, but was indirectly concluded by the reading of the heliothermometer.

The activities of the flies were observed only when the reading of the heliothermometer rose above about 15°C. They are, however, to be fluctuated somewhat, influenced by the fluctuation of the air temperature which is considered to be the basis of the temperature environment. Soon after the sun is obscured, the body temperature may fall to the level of the air temperature and thus the activities are weakened suddenly and remarkably. The insects were still active a little even after the sun was obscured on the 6th and the 12th of December, but they were entirely motionless when the sun was also obscured on the 15th of the same month. The above-mentioned phenomenon seemed to occur from the fact that the air temperature, the basis of the temperature environment, is high or low. In fact the air temperature was 9–10°C on the 6th and 12th days, but it was 2–3°C on the 15th day.

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* Lethal limit of high temperature in Orthoptera: Ecol. Rev., 4, 250–253, 1938.

As was observed in the case of the ecological investigation made on the Strawberry Weevil, *Anthonomus bisignifer* SCHENKLING (KATÔ, 1937–1940)*, the writer thinks that the solar radiant energy must be taken into consideration as one of the environmental temperature factors. This fact was also recognized in the present investigation executed on the activities of the insects which come to the flowers of "Yatude". As the air temperature was low enough not to induce the activities of the insects, the ecological meaning of the solar radiant energy seems to be clearly recognized. Here, it must be noticed that the influence of the solar radiant energy is also affected by and is based upon the fluctuation of the air temperature which may be looked upon as the basis of the temperature environment.

SUMMARY

1. In the present paper the writer dealt with the activities of some insects which came to the flowers of "Yatude", *Fatsia japonica*, during

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*1) A statistical investigation of the correlation between climatic condition and the egg-laying activity of the Strawberry Weevil, *Anthonomus bisignifer* SCHENKLING. Sci. Rep. Tôhoku Imp. Univ., Biol., **11**, 307–321, 1937.

2) Changes occurring in the egg-laying activity of the Strawberry Weevil, *Anthonomus bisignifer* SCHENKLING, in the case of a solar eclipse. Ibid., **11**, 353–359, 1937.

3) The diurnal activity of the Strawberry Weevil with a note of the ecological meaning of the solar radiant energy. Ibid., **12**, 511–530.

4) Body temperature of the Strawberry Weevil and its limiting factors. Ibid., **14**, 11–19, 1939.

5) Diurnal variation in the body temperature of the Strawberry Weevil. Ibid., **15**, 97–103, 1940.

6) The general consideration of the diurnal activity of the Strawberry Weevil and the environmental temperature factors. Ibid., **15**, 179–189, 1940.

the winter time.

2. The activities were investigated mainly of the two kinds of flies, *Eristalomya tenax* and *Calliphola lata*. In winter the activities of these two species of the insects seemed to be governed mainly by the temperature environment.

3. The influence of the solar radiant heat was clearly recognized to induce the activities of these insects, as the air temperature, which forms the basis of the temperature environment, was not so high as to do the same thing.

CYSTINE IN THE AMINO ACID FRACTIONS OF PROTEIN AND THE REACTION OF CYSTINE AND CYSTEINE TO PHOSPHOTUNGSTIC ACID

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Protein was hydrolysed with hydrochloric acid and the hydrolysate was separated into the following fractions: the monoamino acid fraction, the purine fraction, the arginine fraction, the histidine fraction, the lysine-precipitate fraction and the lysine-filtrate fraction (1, 2, 3, 4). If cystine is one of the constituent amino acids of protein, it must be present in some fractions. Hair contains a comparatively large quantity of cystine. Casein contains a small amount of cystine. In the present work, hair and casein were hydrolysed with hydrochloric acid and separated into the amino acid fractions above described. An attempt was made to decide the occurrence of cystine in the fractions.

Mörner reported that cystine is not precipitated by phosphotungstic acid either with or without the addition of hydrochloric acid (5). On the other hand according to E. Winterstein (6) cystine is precipitated by phosphotungstic acid. A dilute solution of cystine in sulphuric acid was added to with some phosphotungstic acid and after standing for 10–20 minutes a crystalline precipitate was settled out. Cystine was separated from the precipitate by ether and hydrochloric acid with a separatory funnel. The present paper deals with the occurrence of cystine in the amino acid fractions prepared from human hair and casein and also the reaction of cystine and cysteine to phosphotungstic acid.

I. THE OCCURRENCE OF CYSTINE IN THE AMINO ACID FRACTIONS OF CASEIN AND HUMAN HAIR. METHOD AND RESULTS

The materials were hydrolysed with hydrochloric acid and after a complete hydrolysis the hydrolysate was evaporated under reduced pressure to remove hydrochloric acid. The hydrolysate thus obtained was dissolved in a 5 per cent. solution of sulphuric acid and precipitated by the addition of a 20 per cent. solution of phosphotungstic acid in 5 per cent. sulphuric acid in the usual manner. After standing for more than 24 hours, the solution was filtered off and washed with a 5 per cent. solution of sulphuric acid. The mixture of the filtrate and the wash solution was the monoamino acid fraction.

The precipitate and the filter paper were transferred into a mortar and ground thoroughly, with the addition of a small amount of water and crystalline barium hydroxide. The solution was made to a faint alkaline reaction and to it was added two volumes of water and then filtered off. CO_2-gas was introduced into the mixture of the filtrate and the wash water to remove barium. The filtrate freed from barium was concentrated under reduced pressure and made to an acid reaction by the addition of dilute nitric acid, using congo-red as an indicator. The solution was precipitated by the addition of a 20 per cent. solution of silver nitrate and filtered off. The precipitate was washed with a silver nitrate solution. The precipitate thus obtained was the purine fraction.

To the filtrate from the purine fraction was added a quantity of silver nitrate until the test resulted in a brown precipitate by the addition of a barium hydroxide solution and to it was then added an excess amount of barium hydroxide. The precipitate was filtered and washed with a barium hydroxide solution. This precipitate was allowed to suspend in water and was then freed from barium and silver by treatment with sulphuric acid and hydrogen sulphide successively. The filtrate from barium sulphate and silver sulphide was concentrated under reduced pressure and to it was added a saturated mercuric sulphate solution in sulphuric acid of 2.5 per cent. concentration. The precipitate was filtered off and washed with a 2.5 per cent. solution of sulphuric acid. The precipitate thus obtained was the histidine fraction. The mixture of the filtrate and the wash solution was the arginine fraction. The filtrate from the brown precipitate, settled out by silver nitrate and barium hydroxide as above described, and the wash solution were combined. The mixture was freed from barium and silver and concentrated under reduced pressure. The solution thus obtained was precipitated by the addition of a 20 per cent. solution of phosphotungstic acid in the presence of 5 per cent. sulphuric acid and filtered off. This precipitate was treated with barium hydroxide and filtered off. The filtrate thus obtained was the lysine fraction. However, in the filtrate from the precipitate settled out by phosphotungstic acid nitrogen compounds were found as usual. The former was named the lysine-precipitate fraction and the latter the lysine-filtrate fraction.

Each amino acid fraction described above was determined for cystine.

The qualitative determination of cystine was summarized as follows:—To each amino acid fraction was added some barium chloride and barium hydroxide to remove sulphuric acid and then filtered off. The filtrate was treated with CO_2–gas to remove barium and then concentrated. The solution thus obtained was analysed for cystine by a modification of OKUDA's iodine method (7, 8, 9). Another method was carried out. The solution was ashed by the addition of the DENIS reagent. Sulphur in the cystine was made to sulphate by oxidation. The sulphate was determined by the benzidine procedure. The results thus obtained are shown in Table I.

TABLE I.
Cystine in amino acid fractions

	human hair	casein
Monoamino acid fraction	+	+
Purine fraction	+	−
Arginine fraction	−	−
Histidine fraction	−	−
Lysine-precipitate fraction	+	−
Lysine-filtrate fraction	+	+

As shown in Table I, the cystine in the hydrolysate of hair and casein was not totally precipitated by the usual addition of phosphotungstic acid. The monoamino acid fraction of hair contained some quantities of cystine and that of casein contained a very small amount of cystine. A small amount of cystine was found to be present in the purine fraction of hair, but it was not detected in that of casein. The arginine and histidine fractions contained no cystine. The lysine-precipitate fraction of hair contained such a small amount of cystine as could only be detected qualitatively, while that of casein contained no cystine. Cystine was found to be present in the lysine-filtrate fraction of casein and hair.

When a dilute solution of cystine in sulphuric acid was added to with some phosphotungstic acid, a crystalline precipitate was not settled out immediately. After a few minutes or in some cases several hours a precipitate appeared gradually. In a relatively concentrated solution of cystine a certain amount was precipitated at once. The facts above stated were proved in the following experiments dealing with the reaction of cystine to phosphotungstic acid. To prepare the lysine-precipitate fraction of casein, phosphotungstic acid was usually added to the lysine solution containing a small amount of cystine, until the precipitate of the phosphotungstates was no longer settled out at once. In such a dilute solution of cystine as the lysine solution of casein, cystine may not possibly be precipitated by the usual addition of phosphotungstic acid. On the other hand in the lysine solution of hair containing a considerable amount of cystine as compared with that in the case of casein, a certain amount of cystine may be rightly considered to be precipitated by phosphotungstic acid.

The monoamino acid fraction of hair was allowed to stand in the cold. Crystals were settled out and appeared in the typical form of cystine under the microscope. The monoamino acid fraction of hair was again treated with phosphotungstic acid in the usual way. The precipitate was settled out and filtered off after standing for 24 hours. The filtrate thus obtained was subjected to the qualitative determination of cystine. Cystine was practically not contained in the filtrate, not so much as could be qualitatively detected with certainty.

II. THE REACTION OF CYSTINE TO PHOSPHOTUNGSTIC ACID

An attempt has been made now to examine the reaction of cystine to phosphotungstic acid. The cystine used in the present experiment was prepared from human hair. The method of preparation of the cystine can be summarized as follows:—Hair was hydrolysed into its constituent amino acids by boiling it under a reflux condenser with concentrated hydrochloric acid, for about six hours, in the proportion of 50 gm. hair to 100 cc. acid. After the complete hydrolysis the hydrolysate was slowly added to with some solid sodium acetate, using congo-red as an indicator. After standing in a refrigerator overnight the precipitate settled out from the solution was filtered off and washed with cold water. It was dissolved in a 4 per cent. boiling solution of hydrochloric acid, to which was added animal charcoal, and then filtered off. The decoloration was carried out repeatedly. The filtrate, completely decolorized, was heated to boiling point and added to slowly with a warm concentrated solution of sodium acetate until it was neutral to congo-red. The cystine was crystallized out and purified by treatment with ammonia and acetic acid (10). The cystine thus prepared was subjected to the determination of nitrogen by KJELDAHL's method and also examined for its rotation. It gave no MILLON's reaction. It was proved to be pure.

The known solution of cystine in 5 per cent. sulphuric acid was added to with a 20 per cent. solution of phosphotungstic acid in 5 per cent. sulphuric acid. After standing for 24 hours the solution was filtered off. The filtrate was subjected to the determination of nitrogen by the method of Kjeldahl. The cystine in the filtrate was calculated from the amount of nitrogen determined. The precipitate of cystine settled out by the addition of phosphotungstic acid appeared at once, or after a few minutes or several hours in proportion to the concentration of cystine in the solution. The results obtained are summarized in the following Tables.

Table II.

Amount of cystine	Phosphotungstic acid added	Amount of cystine not precipitated	Amount of cystine precipitated	
mg.	cc.	mg.	mg.	%
2	0.5	2.00	0	0
2	1	2.00	0	0
2	2	1.84	0.16	8.0
2	3	1.63	0.37	18.5
2	5	1.38	0.62	31.0
2	6	1.37	0.63	31.5
2	7	1.37	0.63	31.5

The concentration of the cystine solution: 0.01%
The total volume of the solution: 20 cc.

Table III.

Amount of cystine	Phosphotungstic acid added	Amount of cystine not precipitated	Amount of cystine precipitated	
mg.	cc.	mg.	mg.	%
4	0.25	4.00	0	0
4	0.5	4.00	0	0
4	1	3.66	0.34	8.5
4	1.5	3.29	0.71	17.8
4	2	3.00	1.00	25.0
4	3	2.36	1.64	41.0
4	4	1.90	2.10	52.5
4	5	1.54	2.46	61.5
4	6	1.29	2.71	67.8
4	7	1.29	2.71	67.8

The concentration of the cystine solution: 0.02%
The total volume of the solution: 20 cc.

TABLE IV.

Amount of cystine	Phosphotungstic acid added	Amount of cystine not precipitated	Amount of cystine precipitated	
mg.	cc.	mg.	mg.	%
10	0.4	9.57	0.43	4.3
10	0.5	8.74	1.26	12.6
10	1	4.03	5.97	59.7
10	2	3.00	7.00	70.0
10	3	1.97	8.03	80.3
10	6	2.00	8.00	80.0
10	8	2.00	8.00	80.0
10	10	2.00	8.00	80.0

The concentration of the cystine solution: 0.05%

The total volume of the solution: 20 cc.

TABLE V.

Amount of cystine	Phosphotungstic acid added	Amount of cystine not precipitated	Amount of cystine precipitated	
mg.	cc.	mg.	mg.	%
20	0.5	13.20	6.80	34.0
20	1	8.48	11.52	57.6
20	2	6.08	13.92	69.6
20	6	3.52	16.48	82.4
20	8	3.50	16.50	82.5

The concentration of the cystine solution: 0.1%

The tolal volume of the solution: 20 cc.

TABLE VI.

Amount of cystine	Concentration of the cystine solution	Total volume of the solution	Phosphotungtic acid added	Amount of cystine not precipitated	Amount of cystine precipitated	
mg.	%	cc.	cc.	mg.	mg.	%
80	0.27	29	9	4.30	75.70	94.6
40	0.16	25	5	3.69	36.31	90.8

As may be seen from the above Tables, it follows that cystine is precipitated in a large quantity by the addition of an excess of phosphotungstic acid. However, in such a dilute solution of cystine as 0.01%

a large amount of cystine is not precipitated by phosphotungstic acid. In a 0.02% cystine solution a large portion of cystine is not precipitated by phosphotungstic acid when the acid added into the solution is small in quantity. In the other cystine solutions described in the above Tables a large part of the cystine is precipitated by the addition of phosphotungstic acid.

III. REACTION OF CYSTEINE TO PHOSPHOTUNGSTIC ACID

Cystine prepared from human hair by the procedure described above was dissolved in a 10 per cent. solution of hydrochloric acid, added to with tin and gently warmed on the water bath. Then H_2S–gas was introduced into the solution and the precipitate formed was filtered off. The filtrate was gently evaporated on the water bath and the residue was dissolved in a 5 per cent. solution of sulphuric acid. The solution of cysteine thus prepared was used in the following experiments.

The known solution of cysteine was added to with a 20 per cent. solution of phosphotungstic acid in 5 per cent. sulphuric acid. After standing for 24 hours the solution was filtered off. The filtrate was submitted to KJELDAHL analysis. The amount of cysteine was calculated from the nitrogen estimated. The results obtained are shown in the following Tables.

TABLE VII.

Phosphotungstic acid added cc.	Amount of cysteine precipitated %
0.5	0
1	0
2	0
3	0
4	0
6	0

The concentration of the cysteine solution: 0.05%
The total volume of the solution: 15 cc.

TABLE VIII.

Phosphotuugstic acid added cc.	Amount of cysteine precipitated %
0.5	0
1	0
2	0
4	4
6	5

The concentration of the cysteine solution: 0.1%
The total volume of the solution: 15 cc.

TABLE IX.

Phosphotungstic acid added cc.	Amount of cysteine precipitated %
0.5	0
1	0
2	0
4	7

The concentration of the cysteine solution: 0.25%
The total volume of the solution: 12 cc.

TABLE X.

Phosphotungstic acid added cc.	Amount of cysteine precipitated %
4	5
8	5

The concentration of the cysteine solution: 0.5%
The total volume of the solution: 24 cc.

As shown in the above Tables, cysteine is not precipitated by phosphotungstic acid. Cysteine may possibly be converted into cystine by phosphotungstic acid. It is considered that the cystine converted from cysteine is partly precipitated by phosphotungstic acid.

I wish here to express my sincere thanks to Dr. S. NOMURA, Professor of Animal Physiology, Biological Institute of the Tôhoku Imperial University, for his kind revision of the present paper.

SUMMARY

The occurrence of cystine in the amino acid fractions of casein and human hair was studied. The reaction of cystine and cysteine to phosphotungstic acid was examined.

LITERATURE

1. HOSOI, K. (1940). Palao Trop. Biol. Sta. Studies, **2**, 51.
2. VAN SLYKE, D. D. (1911–1912). J. Biol. Chem., **10**, 15.
3. UTINO, S. and SHIMAZU, K. (1936). Kagaku Kenkyu Sho Koenshu, **7**, 131.
4. SASAKI, A. (1938). Tôhoku J. Exp. Med., **34**, 561.
5. MÖRNER, K. A. H. (1899). Ztschr. physiol. Chem., **28**, 595.
6. WINTERSTEIN, E. (1902). *ibid*, **34**, 153.
7. OKUDA, Y. (1924). J. Chem. Soc. Japan, **45**, 1.
8. OKUDA, Y. and MOTOMURA, J. (1925). Bull. Agr. Chem. Soc. Japan, **1**, 323.
9. SATO, M., HIRANO, T. and KAN, T. (1939). *ibid.*, **15**, 783.
10. FISCHER, E. and SUZUKI, U. (1905). Ztschr. physiol. Chem., **45**, 405.

CAPRELLIDS OBTAINED IN ONAGAWA BAY, NORTHERN JAPAN

By

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(= FUJIO HIRO)
Seto Marine Biological Laboratory, Sirahama

(With 6 Text-figures)

(Received December 26, 1942)

This paper deals with the Caprellids secured by the members of the Oceano-chemical Institute of the Tôhoku Imperial University at Onagawa, which were submitted to the writer by the kindness of Dr. TAKEO IMAI of the Institute. All the specimens were collected in Onagawa Bay, mostly during the summer of 1935–1937.

Six species are represented in the collection, of which one seems to be new to science. The Caprellid fauna in this district is apparently very poor, and it is rather noteworthy that the material consists largely of the two boreal forms, *Caprella acanthogaster* and *C. kröyeri*. So the main component of the fauna of Onagawa Bay, as far as the Caprellids are concerned, seems to be similar to that of Mutu Bay at the north end of Hondô. Further northward, they are replaced by *C. bispinosa* (cf. UTINOMI; Caprellids of Akkeshi Bay).

Before proceeding further, I have to record my cordial thanks to Prof. HÔZAWA and Dr. T. IMAI for their kindness in supplying me with the material and in publishing the present paper.

1. **Caprella acanthogaster** MAYER

(Fig, 1)

Caprella acanthogaster, MAYER, 1890, p. 80; MAYER, 1903, p. 78.

Occurrence: 1) Off Yoriiso to Matazima. Dredged from depth 39 m. Bottom—sand, shell shingle, 1 ♂ (Sp. No. 890). 23/VIII '35.

2) Takenoura. Trawled at depth 12 m. Bottom—mud, sand and seaweeds. 2 ♂ (Sp. No. 1285). 19/V '36.

3) Koyatori. Dredged from depth 14 m. Bottom—shingle, shell. 1 ♀ (Sp. No. 757). 19/VII '35.

4) Ommae-wan. Dredged from depth 8 m. Bottom—sand, mud,

shingle, covered with *Ceramium rubrum*. 1 ♀ (Sp. No. 567 diii). 17/VII '35.

5) Iikohama. On submerged iron-plates. 1 ♂ 2 ♀ (Sp. No. B 108). 2/VIII '37.

6) Izusima. On submerged iron-plates. 2 ♀ (Sp. No. B 105). 7/IX '36.

7) Izusima. On submerged iron-plates. 1 ♀ (Sp. No. B 107). 13/XI '36.

8) Off Miyagasaki. Dredged from depth 6 m. Bottom—mud and sea-weeds. 1 ♀ (Sp. No. 519 B). 16/VII '35.

9) Onagawa Harbour. On leaf of *Ceramium rubrum*. 3 ♂ 1 ♀ (Sp. No. I–6). 2/VIII '35.

Distribution: "Reise von China nach der Amurmündung, Kapt. VOLLBARTH.", Wladywostok, Nakabuta (Hokkaidô). (MAYER).

This species is characterized in both sexes by the numerous pairs of strong spines on the back and also by the strong spines arranged in row around the base of gills. In very old males (over 42 mm in length), according to MAYER (1903), the head and peraeon segment 1 are smooth without any dorsal spines, but in the present specimens these dorsal spines are

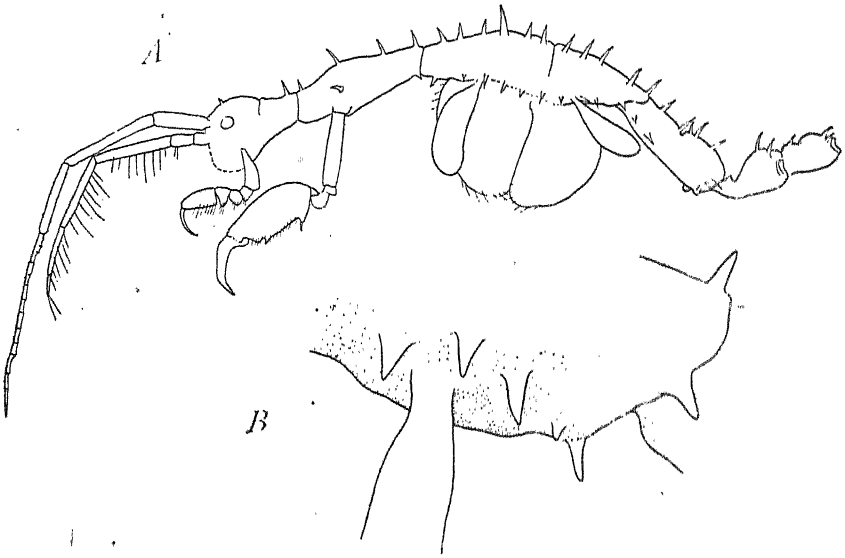

Fig. 1. *Caprella acanthogaster* MAYER.
A, ♀ (no. B 108), ×10. *B*, ventrolateral part of peraeon segment 4 of ♂, ×34.

distinct. The spines vary in number according to the state of development or the size of each peraeon segment. It is noteworthy that the female has a pair of peculiar tubercles on the under side of peraeon segment 5 a little in front of the hind end—a feature overlooked by previous authors. A similar protuberance is present in the same segment of the female in a number of other species, such as *Caprella aequilibra*, *C. alaskana*, *C. obtusifrons*, *C. paulina*, *C. striata* etc. Although its function is unknown, it is certainly one of the secondary sexual characters.

2. **Caprella acutifrons** Latr. **f. neglecta** Mayer

(Figs. 2 A & 3 A)

Caprella acutifrons, Mayer, 1882, p. 48 (with synonymy).
Caprella acutifrons var. *neglecta*, Mayer, 1890, p. 55.
Caprella acutifrons var. *natalensis*, Arimoto, 1930, p. 16; Hiro, 1937, p. 312.

Occurrence: 1) Izusima. On submerged iron-plates. Immature 1 ♂ (var. ?) (Sp. No. B 107). 13/XI '36.

2) Izusima. On submerged iron-plates. 2 ♂ 8 ♀ (Sp. No. B 106). 13/XI '36.

3) Onagawa Harbour. On fishing nets. 28 ♂ 23 ♀ (Sp. No. B 103). 7/XI '35.

4) Isihama. On rocky shore. 1 ♂ 1 ♀ (Sp. No. 418). 14/VII '35.

5) Onagawa Harbour. On submerged iron-plates. 1 ♂ 1 ♀ (Sp. No. B 102). 25/X '35.

Distribution: Hongkong, Formosan Channel, Nagasaki, Enoura (Mayer), Tateyama (Arimoto), Tanabe Bay (Hiro).

This form, which has been wrongly identified as var. *natalensis*, is very common on the coast of Japan proper. Most of the specimens in this collection are referable to var. *neglecta* by the shape of the antennae and gnathopod 2. There is scarcely any distinctive character between these two forms. Specimens No. B 106 include an old female, of which the body is more like that of var. *testudo* while the gnathopod 2 is like that of var. *simulatrix*, both known from the coast of France. For comparison this female is described below:—

Length 13 mm. Body very plump and smooth. Head with a short triangular frontal process, separated by an indistinct suture from peraeon segment 1 and about as long as the latter. Peraeon segment 2 longer than head + peraeon segment 1, somewhat swollen at the front and in the middle. Peraeon segments 3–4 subequal in length, very plump; its lateral plate broadly expanded downwards and covers base of gills, so as to form a "Flügel"; its anterior ventro-lateral corner projecting forwards in rounded outline; hindend of back of segment 4 slightly upraised. Peracon segment 5 with a large tubercle near fore end on each side.

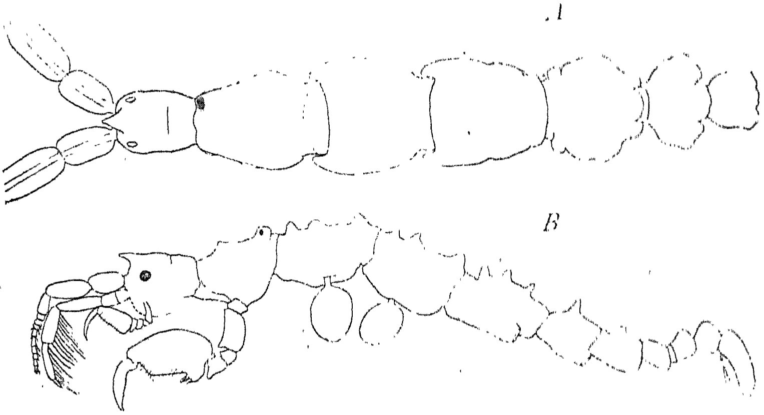

Fig. 2. *Caprella acutifrons* LATREILLE.
A, forma *neglecta*, over-grown ♂ (no. B 106), ×7. *B*, forma *verrucosa*, ♀ (no. B 106), ×15.

Two basal joints of antenna 1 very plump, about half as wide as head; flagellum composed of 13 joints and a little shorter than peduncle. Joints 1–4 of antenna 2 about 3/2 as long as joints 1+2 of antenna 1. Gnathopod 2 attached to the middle of segment 2, short; hand longer than twice the length of stalk; palm densely setose, slightly concave; neither trace of clasping spine nor poison tooth; claw rather short, with a sharp terminal denticle, its inner margin not indented. Gills round, large. Three pairs of posterior peraeopods very broad, plump; joint 5 fringed with 14 spines on distal margin of under side; clasping spines on palm proximal.

As may be inferred from the above description, in the form of the body, antennae and the gnathopod 2 this species varies considerably with age or environmental conditions.

3. **Caprella acutifrons** LATR. f. **verrucosa** (BOECK)

(Figs. 2 B & 3 B)

Caprella verrucosa, BOECK, 1871, p. 38; MAYER, 1882, p. 69; MAYER, 1890, p. 73.
Caprella acutifrons var. *verrucosa*, MAYER, 1903, p. 83; ARIMOTO, 1930, p. 17.

Occurrence: Izusima. On submerged iron-plates. 2 ♂ (Sp. No. B 106). 13/XI '36.

Distribution: Misaki, Yokohama (MAYER), Tateyama Bay (ARIMOTO), S. Californian coast (MAYER).

This form is characterized by having broad and obtuse dorsal tubercles, whose typical arrangement is: Head–1, S_1–1 or 0, S_2–2, S_3–3, S_4–3, S_5–3 pairs, S_6–1 or 2 pairs, S_7–1 pair. The peduncle of antenna 2 is a little longer and more slender than the peduncle of antenna 1. The palm of gnathopod 2 is somewhat convex, a poison tooth is found close proximal to the clasping spine, while the claw is sharp and devoid of the terminal denticle. In peraeon segments 5–7, the clasping spines of hand are proximal, and joint 5 is usually armed with 8 spines on the under surface of the distal margin. Length 12.4 mm (♂).

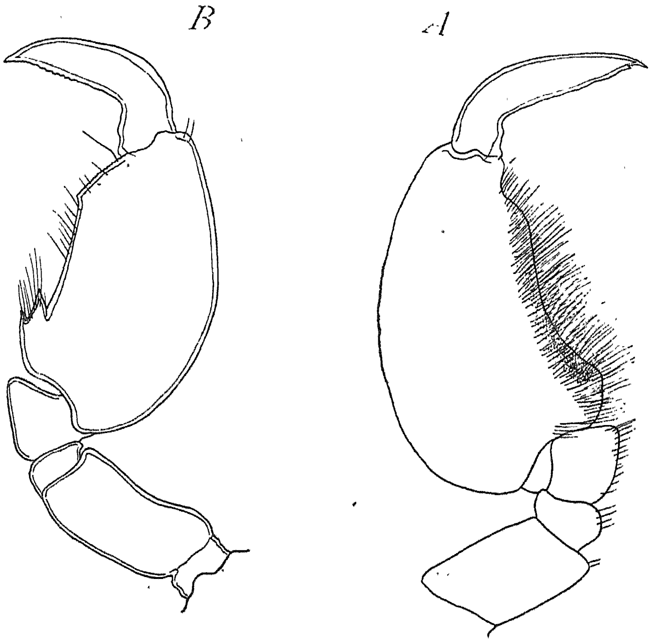

Fig. 3. *Caprella acutifrons* LATREILLE.
A, gnathopod 2 of forma *neglecta* ♂, ×25. *B*, the same of forma *verrucosa* ♂, ×38.

4. **Caprella danilevskii** CZERNIAWSKI

Caprella danilevskii, MAYER, 1882, p. 54; MAYER, 1890, p. 58; MAYER, 1903, p. 99; ARIMOTO, 1930, p. 18; HIRO, 1937, p. 312.

Occurrence: Isihama. On rocky shore. 1 ♀ (Sp. No. 418). 14/VII '35.

Distribution: In Japan, previously known from Korea Strait, Southern Saghalien (MAYER), Tateyama (ARIMOTO) and Tanabe Bay (HIRO).

5. Caprella imaii n. sp.

(Figs. 4 & 5)

Occurrence: Izusima. On submerged iron-plates. 6 ♂ 2 ♀ (Sp. No. B 104). 7/IX '36.

Length 5–6 mm in both sexes. Body moderately slender and tuberculate. Head smooth, but often armed with a pair of minute dorsal tubercles; eyes small. Peraeon segment 1 about half as long as head, smooth or with a pair of minute tubercles at the hind end. Peraeon segment 2 about thrice as long as segment 1, provided with 1 to 3 pairs of dorsal tubercles and with a ventro-lateral tubercle turned backwards at the hind end. Peraeon segments 3–4 subequal in length, armed with 5 or 6 pairs of dorsal tubercles placed with the same intervals between, of which the last one at the hind end of segment 4 is somewhat sharply pointed backward, and also with a ventro-lateral tubercle at the fore and hind end on each side. Peraeon segment 5 as long as segment 4, divided by a median transverse constriction into two parts, each of which is armed with two pairs of dorsal tubercles; two lateral tubercles present near the fore end. Peraeon segment 6–7 with a pair of dorsal tubercles of which the last one may be absent. Peraeon segments 5–7 provided with an acute tooth above the point of attachment of peraeopods.

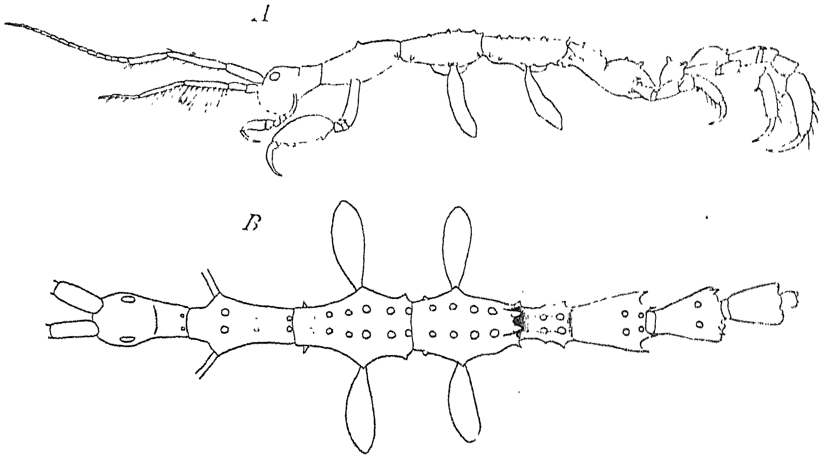

Fig. 4. *Caprella imaii*, n. sp.
A, lateral view of ♂ (no. B 104), ×10. *B*, dorsal view of the same, ×13.

Antenna 1 slender and longer than half of body length; flagellum a little shorter than peduncle and 12– to 14–articulate. Antenna 2 longer than peduncle of antenna 1. Gnathopod 2 in ♂ attached to the centre of peraeon segment 2, but in ♀ near the fore end; 2nd joint a little longer than half of the length of peraeon segment 2 and acutely pointed at the fore distal end; hand oblong, sparsely hairy; palm somewhat convex, proximally with a slightly projecting palmar angle bearing a spine, and somewhat distally with a small poison tooth separated by a narrow sinus from a broad distal projection; claw with slightly serrated inner margin. Gills club-shaped, longer than stalk of gnathopod 2.

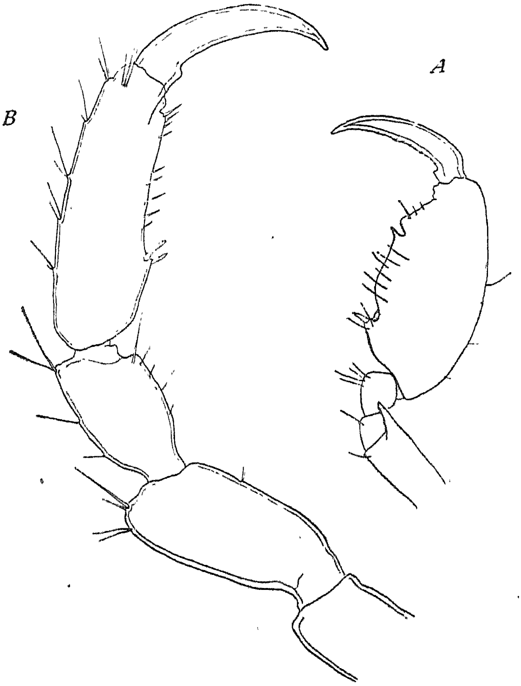

Fig. 5. *Caprella imaii* n. sp. *A*, gnathopod 2 o ♂, ×34. *B*. peraeopod 7 of ♂, ×54.

Peraeopods 5–7 quite alike in outline, though peraeopod 7 is twice as long as peraeopod 5. Hand cylindrical, about thrice as long as wide, and armed submedially with clasping spines; its fore margin with 5 clusters of bristles. Finger with smooth inner margin.

Affinity of the species. This species is closely allied to *Caprella angulosa* MAYER recorded from the east coast of Kamtchatka, but differs from it in having more numerous tubercles on the back. The number of tubercles is not very variable in both sexes at least in the present collection. Thus for the present it seems best to treat the present specimens apart from *C. angulosa*, until an actual comparison with the typical examples of the latter species is made.

6. Caprella kröyeri DE HAAN

(Fig. 6)

Caprella kröyeri, DE HAAN, 1849, p. 228· MAYER, 1882, p. 70; MAYER, 1890, p. 74;

Mayer, 1903, p. 107; Arimoto, 1931, p. 11.
Caprella spinosa, Lockington, 1875, p. 405.

Occurrence: 1) Onagawa Harbour. On *Ceramium rubrum*. 1 ♂ 1 ♀ (Sp. No. I–6). 2/VIII '35.

2) Ommae-wan. Dredged from depth 8 m. Bottom—sand with sea-weeds. 5 ♂ 2 ♀ (Sp. No. 567 d). 17/VII '35.

3) Iikohama. Dredged from depth 8.4 m. Bottom—sand with sea-weeds. 4 ♂ 1 ♀ (Sp. No. 615 a). 18/VII '35.

4) Off Nonohama. Dredged from depth 4.6 m. Bottom—sand, mud, sea-weeds. 1 ♂ (Sp. No. 625 e). 18/VII '35.

5) Off Takasiro. Dredged from depth 7.5 m. Bottom—sand, rock. 2 ♂ (Sp. No. 662 c). 18/VII '35.

6) Takenoura, on fishing-nets for sea-cucumbers. Depth 12 m. Bottom—sand, mud, sea-weeds. 1 ♂ (Sp. No. 1030). 14/VIII '35.

7) Takenoura, on fishing-nets for sea-cucumbers. Depth 12 m. Bottom—sand, mud, sea-weeds. 2 ♂ (Sp. No. 1284). 1 ♂ 1 ♀ (Sp. No. 1285). 19/V '36.

8) Iikohama. On submerged iron-plates. 4 ♂ 2 ♀ (Sp. No. B 108). 2/VIII '37.

Distribution: Wladywostok, Tsingtau, Hakodate, Tateyama, Misaki, Ômori (Mayer, Arimoto).

This species is one of the large-sized caprellids, and very common in the northern region of Japan proper. The largest one (♂) (Sp. No. 1284) is 58.2 mm long and give measurements as follows (in mm):

Head 2.0; Peraeon segments 1–7—11.3, 15.4, 8.6, 8.0, 7.8, 3.7, 3.5; Antenna 1–48; Antenna 2–12, Gnathopod 1–5.6; Gnathopod 2–21.8; Gill 8.

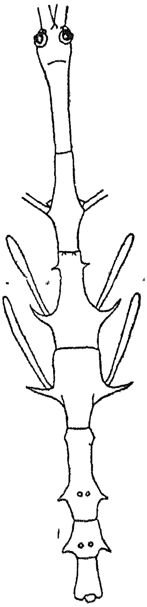

Fig. 6.
Caprella kröyeri
de Haan, ♂ (no. 1284), ×8.

Body slender, long and covered with numerous granules bearing each a sensory hair all over. Head apparently smooth, though having a pair of minute teeth between the base of antenna 1 and eye. Eyes rather large and prominent. Peraeon segment 1 very long, its length variable with age. Gnathopod 2 in old ♂ articulated near the hind end of peraeon segment 2, but in younger stage it is attached to the centre. Peraeon segment 2 somewhat swollen at the base of gnathopod 2. Peraeon segments 3–4 subequal in length and armed on each side with a sharp, long projection bent forward above the point of articulation of gill; besides, a sharp lateral projection near the fore end of segment 3. These projections are most characteristic of this species, although in younger stages they are often indistinct.

STEBBING (1888, p. 1633) emphasizes that *Caprella spinosa* LOCKINGTON (1875) recorded from Hakodadi (=Hakodate) Bay is the same as *C. scaura* TEMPLETON. LOCKINGTON's statement:—"No spine on dorsal surface of head........The third and fourth segments armed with a long, sharp spine, the point curving towards the head.....", clearly shows the identity of his *spinosa* to *C. kröyeri*, but not to *C. scaura*, as pointed out by MAYER.

7. **Caprella scaura** TEMPLETON f. **diceros** MAYER

Caprella scaura f. *diceros*, MAYER, 1890, p. 70; MAYER, 1903, p. 118.
Caprella scaura, STEBBING, 1888, p. 1257; ARIMOTO, 1931, p. 16; HIRO, 1937, p. 314.

Occurrence: 1) Onagawa Harbour. On submerged iron-plates. 3 ♂ (Sp. No. B102). 25/X '35.

2) Izusima. On submerged iron-plates. 3 ♂ 2 ♀ (Sp. No. B107). 13/XI '36.

3) Off Koyatori. Dredged from Depth 14 m. Bottom—Shell shingle. 1 ♂ (Sp. No. 757). 19/VII '35.

Distribution: Off Kôbe (STEBBING), Ômori, Tateyama, Kaziyama, Misaki, Enoura, Nagasaki, Formosa Strait (MAYER), Tanabe Bay (HIRO).

LITERATURE

ARIMOTO, I., (1929). Studies on the Caprellidae from Tateyama. I. Hakubutugaku-zassi, vol. 27, no. 38. (Japanese)

——, (1930). Idem. 2. Ibid., vol. 28, no. 39. (Japanese)

——, (1931). Idem. 3. Ibid., vol. 29, no. 41. (Japanese)

HIRO, F., (1937). Caprellids from Tanabe Bay. Ann. Zool. Jap., vol. 16, no. 4.

LOCKINGTON, W. N., (1875). Observations on the genus *Caprella*, and the description of a new species. Proc. Calif. Acad. Sci., vol. 5, for 1873–1874.

MAYER, P., (1882). Caprelliden. Fauna und Flora des Golfes von Neapel. mon. 6.

——, (1890). Nachtrag zu den Caprelliden. Ibid., mon. 17.

——, (1903). Die Caprellidae der Siboga-Expedition. Siboga-Expeditie, mon. 34.

STEBBING, T. R. R., (1888). Report on the Amphipoda collected by H. M. S. CHALLENGER during the years 1873–76. Sci. Rep. CHALLENGER Exped., Zool., vol. 39, pt. 67.

REPORT OF THE BIOLOGICAL SURVEY OF MUTU BAY

37. CAPRELLIDS FROM ASAMUSI[1]

BY

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(= FUJIO HIRO)
Seto Marine Biological Laboratory, Sirahama

(With 6 Text-figures)

(Received December 26, 1942)

The material of caprellids dealt with in this paper was secured chiefly by Dr. NOBORU ABE, formerly an assistant in the Asamusi Biological Station, in the vicinity of the station in June–September, 1938, and placed in my hands shortly afterwards. Besides, there are some specimens obtained by Dr. KÔJIRO KATÔ from the same locality. Seven species including a new one are represented.

I, herewith, express my sincere thanks to Prof. S. HÔZAWA, and to Drs. N. ABE and K. KATÔ who kindly the materials at my disposal.

DESCRIPTION OF THE SPECIES

1. **Caprella acanthogaster** MAYER

(Fig. 1)

MAYER, 1890, p. 80; MAYER, 1903, p. 78; UTINOMI, 1943, p. 271.

1) 17 ♂ 5 ♀, from the ascidian *Chelyosoma siboja*. Off Asamusi,

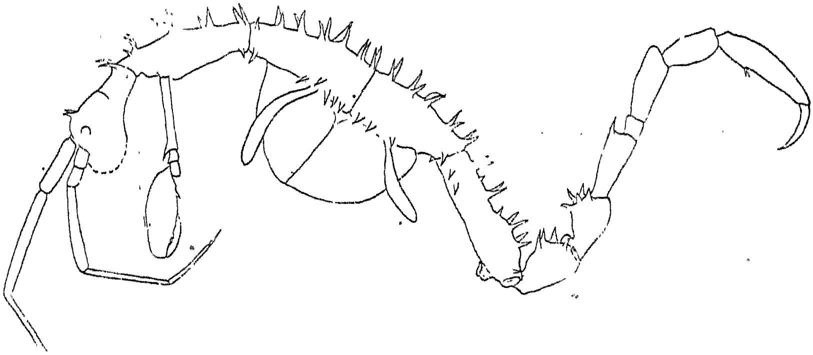

Fig. 1. *Caprella acanthogaster* MAYER, ♀. ×10.

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[1] Contribution from the Marine Biological Station, Asamusi Aomori-ken, No. 176.

25 m in depth. 6–VIII–1938. N. ABE.

2) 5 ♂ 6 ♀. Off Asamusi, 5–10 fathoms. VI–1938. K. KATÔ.

The description of this species is given in another paper dealing with the material from Onagawa Bay. So I give here a sketch of a female illustrating the typical arrangement of the paired dorsal projections. Those show considerable variation according to age, but very little sexual differentiation.

Distribution in Japan. Hokkaidô, Onagawa Bay.

2. **Caprella acutifrons** LATR. f. **neglecta** MAYER

(Fig. 2)

1) Numerous ♂ and ♀ specimens, on *Undaria pinnatifida.* Kamome-zima. 20–VI–1938. N. ABE.

2) 27 ♂ 14 ♀, on *Sargassum Thunbergi.* Off Asamusi. II–1938. N. ABE.

In some full-grown males (over 10 mm long) among the material, the 2 basal joints of antenna 1 are very plump and longer than the peduncle of antenna 2, though shorter in younger ones. The flagellum of antenna 1 is slender and shorter than the 2nd joint and composed of 12 to 14

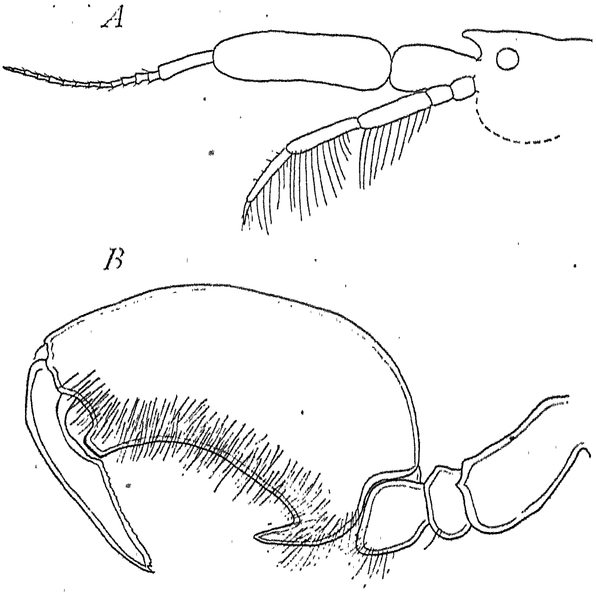

Fig. 2. *Caprella acutifrons* LATR. f. *neglecta* MAYER, over-developed ♂. *A*, antennae and head, ×10. *B*, gnathopod 2, ×10.

joints. Because of this character, such specimens approach the pelagic form *Andreae*. Yet in other characters, especially of gnathopods and peraeopods mentioned below, it conforms well with the littoral form *neglecta*:—

Hand of gnathopod 2 very plump; palm long, concave, thickly setose and devoid of poison tooth (Giftzahn); palmar angle proximal, strongly projecting downwards, but without any trace of spine at its end; distal angle protuberant and broadly truncated; claw proximally with a deep concavity to which the corresponding projection of palm is fitted, and distally with a small denticle continued from the indented inner margin.

In peraeopods 5–7, hand segment armed proximally with clasping spines; under side of distal margin of 5th joint fringed with 8–10 spinules.

Distribution. From Hokkaidô to Taiwan, Hongkong.

3. **Caprella bispinosa** MAYER

(Fig. 3)

Caprella bispinosa, MAYER, 1890, p. 82; MAYER, 1903, p. 94;

1 ♀. Off Asamusi, 5–10 fathoms. VI–1938. K. KATÔ.

Female. Length 8.5 mm. Head smooth, eyes small. Peraeon segment 1 a trifle shorter than head, and armed with a hook-like dorsal projection at the hind end. Peraeon segment 2 about four times as long as peraeon

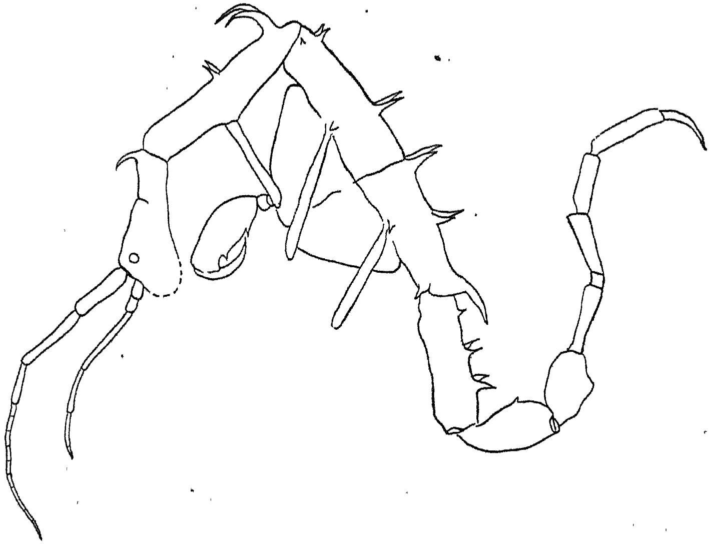

Fig. 3. *Caprella bispinosa* MAYER, ♀, ×15.

segment 1, armed with a pair of short upright projections in the middle, and a pair of long hook-like ones strongly bent forward at the hind end. Peraeon segment 3 as long as segment 2, and with 2 pairs of upright projections. Peraeon segment 4 as long as segment 3, and armed with a pair of upright projections at the anterior, a pair in the middle, and a strong process curved backward at the posterior; posterior ventro-lateral corner sharply pointed. Peraeon segment 5 nearly as long as segment 4, and armed with 3 pairs of short sharp projections.

Antenna 1 slender, a little shorter than half the body length; peduncle rather slender and shorter than antenna 2; flagellum 11-articulate. Antenna 2 about two-thirds as long as antenna 1. Gnathopod 2 attached to the centre of peraeon segment 2; 2nd joint long, slender and pointed distally; palm slightly convex, distally with a poison tooth, and more proximally with a spiniferous palmar angle projecting downwards, and 2 accessory spines near proximal pocket of palm. Gills long and linear. Hand of peraeopods 5–7, devoid of clasping spines.

Distribution. 45°40′ N. 135° E (Between southernmost end of Saghalien and Maritime Prov. of Siberia, "Reise von China nach der Amurmündung", Wladywostok (MAYER).

4. Caprella danilevskii CZERNIAWSKI

(Fig. 4)

MAYER, 1882, p. 54; MAYER, 1890, p. 58; MAYER, 1903, p. 99; ARIMOTO, 1930, p. 18; HIRO, 1937, p. 317; UTINOMI, 1943, p. 275.

1 ♂, on *Sargassum Thunbergi.* Off Asamusi, littoral. II–1938. N. ABE.

Distribution in Japan. Southern Saghalien, Korea Strait, Tateyama, Tanabe Bay, Onagawa Bay.

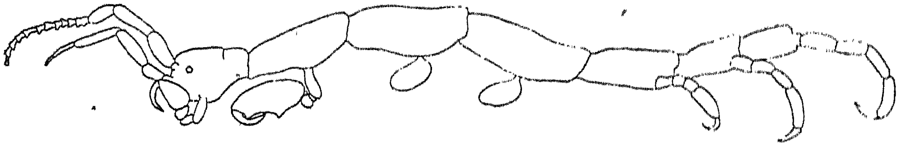

Fig. 4. *Caprella danilevskii* CZERNIAWSKI, ♂, ×8.5.

5. Caprella kröyeri DE HAAN

DE HAAN, 1849, p. 228; MAYER, 1882, p. 228; MAYER, 1882, p. 70; MAYER, 1890, p. 74; MAYER, 1903, p. 107; ARIMOTO, 1931, p. 11; UTINOMI, 1943, p 277.

1) 1 ♂. Asamusi, on *Zostera marina.* 6 m in depth. 30–VIII–1938. N. ABE.

2) 19 ♂ 4 ♀. Asamusi, on *Zostera marina*. 7 m in depth. 27-IX-1938. N. ABE.

3) 1 ♂. Asamusi. 5–10 fathoms. VI–1938. K. KATÔ.

Distribution in Japan. Hakodate, Onagawa, Tateyama, Ômori, Misaki. Also known from Wladywostok and Tsingtau.

6. Caprella scaura TEMPLETON f. diceros MAYER

(Fig. 5)

1) 1 ♂. Asamusi. 5–10 fathoms. VI–1938. K. KATÔ.

2) 2 ♂. Asamusi, on *Sargassum Thunbergi*. II–1938. N. ABE.

Distribution in Japan. All around the coast of Japan, and Formosan Strait.

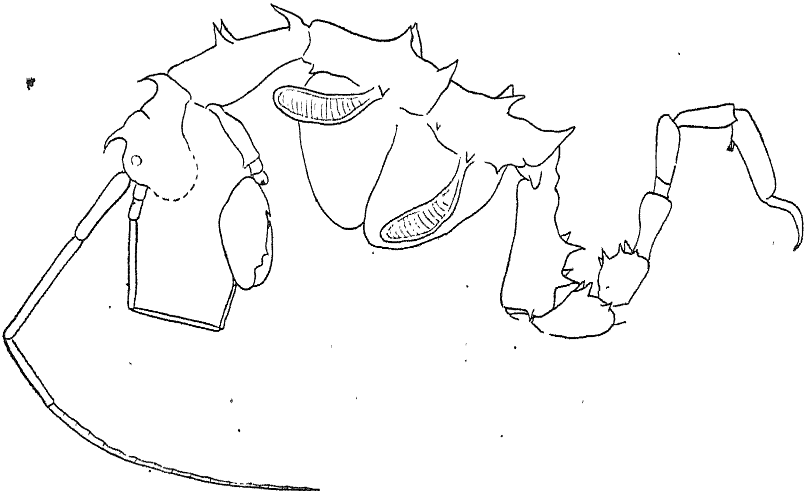

Fig. 5. *Caprella scaura* TEMPLETON f. *diceros* MAYER, ♀. ×10.

7. Caprella venusta, n. sp.

(Fig. 6)

2 ♂. Asamusi, on *Sargassum Thunbergi*. II–1938. N. ABE.

Male 12.2 mm in length. Body slender and smooth. Head and peraeon segment 1 subequal in length. Peraeon segments 2–3 subequal in length and a trifle shorter than thrice as long as segment 1. Peraeon segment 5 slightly shorter than segment 4. Peduncle of antenna 1 16-jointed, a little shorter than flagellum. Antenna 2 slightly longer than peduncle of antenna 1; flagellum fringed with paired serrated bristles. Gnathopod 2 attached nearly to the middle of segment 2; 2nd joint shorter than half as long as peraeon segment 2, smooth and not pointed distally; 4th joint oval; hand oblong, with evenly convex front and hind margins; palm long with a sharp poison tooth distally, separated by a narrow sinus from triangular distal projection; palmar angle nearly proximal, projecting downward, and armed with a spine at its end; claw long, with smooth inner

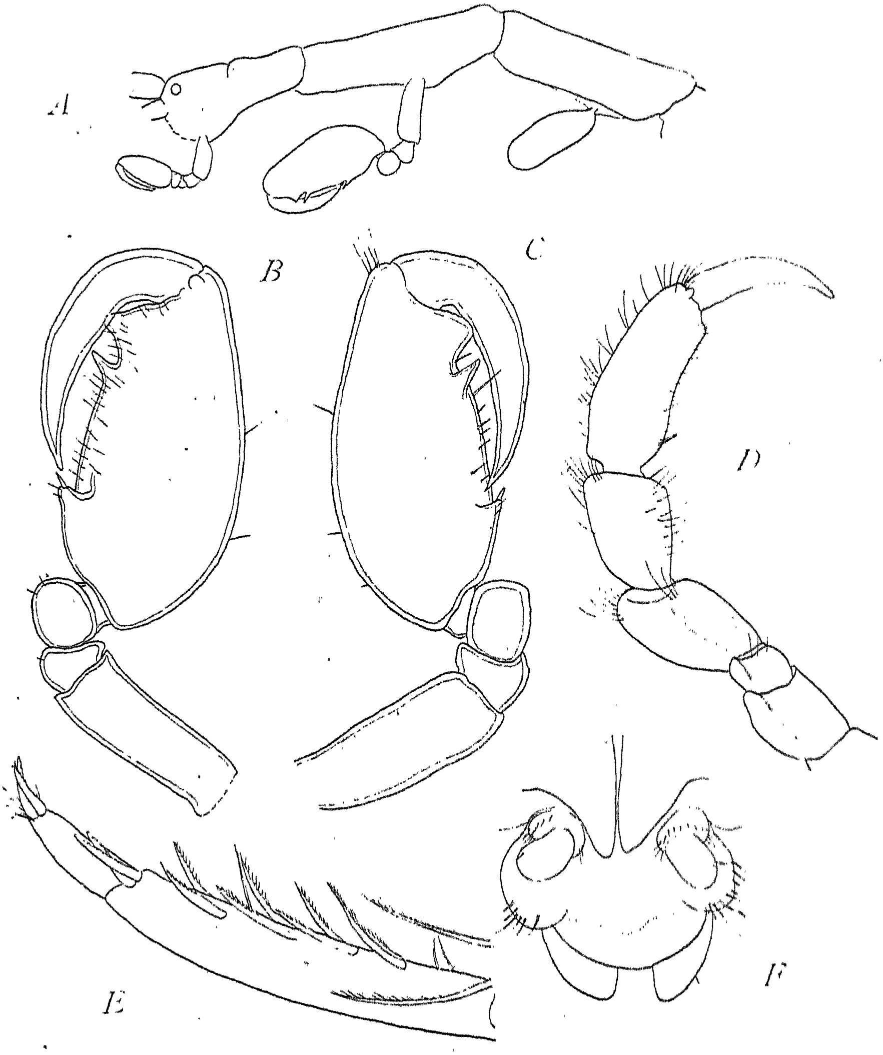

Fig. 6. *Caprella venusta*, n. sp. *A*, frontal part of body of ♂ ×10. *B*, *C*, gnathopod 2 of ♂, ×34. *D*, peraeopod 7, ×34. *E*, flagellum of antenna 2, ×97. *F*, abdomen of ♂, ×97.

margin. Gills oblong, nearly as long as 2nd joint of gnathopod 2. Three pairs of posterior peraeopods somewhat slender; hand about thrice as long as wide, devoid of clasping spines. Abdomen of ordinary type; penes medial; 1st pleopod 2-jointed, short; 2nd pleopod of a simple lobe.

In the general outline of the body, the present specimen is more akin to *Caprella danilevskii* and *C. aequilibra* than to any other. However it can be distinguished from both the species in the absence of a ventral tooth at the base of gnathopod 2, and in the structure of gnathopod 2.

The collection of caprellids from Akkesi Bay, Hokkaidô, which I have examined, contains a specimen of this new species.

LITERATURE

ARIMOTO, I., (1929). Studies on the Caprellidae from Tateyama. 1. Hakubutugaku-zassi, vol. 27, no. 38. (Japanese)

——, (1930). Idem. 2. Ibid., vol. 28, no. 39. (Japanese)

——, (1931). Idem. 3. Ibid., vol. 29, no. 41. (Japanese)

HAAN, W. DE, (1835–1850). Fauna Japonica, edit. by Ph. Fr. DE SIEBOLD. Crustacea.

HIRO, F., (1937). Caprellids from Tanabe Bay. Ann. Zool. Jap., vol. 16, no. 4.

MAYER, P.. (1882). Caprelliden. Fauna und Flora des Golfes von Neapel, mon. 6.

——, (1890). Nachtrag zu den Caprelliden. Ibid., mon. 17.

——, (1903). Die Caprellidae der Siboga-Expedition. Siboga-Expeditie, mon. 34.

UTINOMI, H., (1943). Caprellids obtained in Onagawa Bay, northern Japan. Sci. Rep. Tôhoku Imper. Univ., 4th ser., Biol., vol. 17, no. 3.

WEITERE UNTERSUCHUNGEN ÜBER DEN ASKORBINSÄURE-GEHALT DER KRAUTPFLANZEN, MIT BESONDERER BERÜCKSICHTIGUNG DER SCHATTENPFLANZEN

Von

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Bisher sind zahlreiche Untersuchungen über den Askorbinsäure-Gehalt der Pflanzen berichtet worden. In bezug auf die Krautpflanzen können wir auch einige Untersuchungen finden, die sich damit beschäftigen (Fujita und Ebihara '37, Miwa '38, '39, Sato und Watanabe '39, Moldtmann '39, Koizumi und Kakukawa '40, Bukatsch '40 u. s. w.). In unserer vorangehenden Arbeit (Koizumi und Kakukawa '40) teilten wir mit, dass der Gehalt an Askorbinsäure der Schattenpflanzenblätter im allgemeinen geringer sei als der der Sonnenpflanzenblätter. Dabei wiesen wir auch darauf hin, dass der verhältnismässig reichere Gehalt an oxidierter Askorbinsäure, der sogenannten Dehydroaskorbinsäure, in der Schattenpflanze im Gegensatz zur Sonnenpflanze eine gewisse Bedeutung für die Photosynthese hätte, was aber noch einer weiteren eingehenderen Untersuchung in dieser Richtung bedarf.

Um diesen Verhalt klarzustellen, habe ich besonders über den Askorbinsäure-Gehalt der Schattenpflanzen zu berichten beabsichtigt. Vor Eingehen zur Hauptsache ist hier am Ort, einige nachträgliche Prüfungen über die Methode der Askorbinsäurebestimmung einzuschalten.

I. EINIGE NACHTRÄGLICHE PRÜFUNGEN DER BESTIMMUNGSMETHODE FÜR DIE ASKORBINSÄURE

Zur Bestimmung der Askorbinsäure wird seit Tillmans ('30) die Titrationsmethode mittels 2, 6–Dichlorophenolindophenols oder deren Modifikation nach Harris und Ray ('33) am häufigsten angewandt. Unser vorliegender Versuch wurde aber mittels der von Okuda und Katai ('39) verbesserten Methode ausgeführt.

Nun wird die Prüfung einiger Punkte dieser Methode vorgenommen.

(1) *Der Einfluss der Konzentration der Metaphosphorsäure auf die Stabilität der Askorbinsäure.*

Es wird allgemein anerkannt, dass die Askorbinsäure in Metaphosphorsäurelösung beständig ist, sodass die Enteiweissung gewöhnlich durch diese Säure vorzogen wird (FUJITA und IWATAKE '35, OKUDA und KATAI '39). So wurde zunächst geprüft, welche Konzentration der Metaphosphorsäure für die Stabilität der Askorbinsäure geeignet ist.

Die Enzymlösung wurde nach TAUBER und KLEINER ('31) hergestellt, und zwar wurden 5 gr einer geschälten Kartoffel im Mörser zerrieben, wonach 15 ccm 30%igen Alkohols hinzugefügt und nach 5 Min. dieser Auszug filtriert wurde. Das Filtrat wurde als Enzymlösung in den folgenden Versuchen angewandt. Die untersuchte Konzentration der Metaphosphorsäure war 15, 10, 5, 2, 1 und 0,5% und als Kontrolle wurde destilliertes Wasser benutzt.

Die erhaltenen Ergebnisse sind in Tabelle 1 zusammengestellt.

TABELLE 1.
Einfluss der Konzentration der Metaphosphorsäure auf die Stabilität der Askorbinsäure

Konzentration der Metaphosphorsäurelösung(%)	Reagenzien		Zeit nach Zusatz des Enzyms in Min.				Temperatur
			0	20	40	60	
15	5 ccm der 60%igen Metaphosphorsäure + 5 ccm der Enzymlösung + 10 ccm der Askrobinsäurelösung	Gefundene Askorbinsäure in mg/ccm	0, 143 *100, 0	0, 141 *98, 6	0, 140 *97, 9	0, 139 *97, 3	7, 0°
10	5 ccm der 40%igen Metaphosphorsäure + 5 ccm der Enzymlösung + 10 ccm der Askorbinsäurelösung		0, 141 *100, 0	0, 138 *97, 9	0, 138 *97, 9	0, 137 *97, 2	7, 8°
5	5 ccm der 20%igen Metaphosphorsäure + 5 ccm der Enzymlösung + 10 ccm der Askorbinsäurelösung		0, 146 *100, 0	0, 146 *100, 0	0, 145 *99, 3	0, 145 *99, 3	7, 2°
2	5 ccm der 8%igen Metaphosphorsäure + 5 ccm der Enzymlösung + 10 ccm der Askorbinsäurelösung		0, 155 *100, 0	0, 155 *100, 0	0, 155 *100, 0	0, 155 *100, 0	7, 0°
1	5 ccm der 4%igen Metaphosphorsäure + 5 ccm der Enzymlösung + 10 ccm der Askorbinsäurelösung		0, 175 *100, 0	0, 175 *100, 0	0, 175 *100, 0	0, 175 *100, 0	7, 8°
0, 5	5 ccm der 2%igen Metaphosphorsäure + 5 ccm der Enzymlösung + 10 ccm der Askorbinsäurelösung		0, 167 *100, 0	0, 167 *100, 0	0, 165 *98, 8	0, 165 *98, 9	7, 2°
Kontrolle	5 ccm des dest. Wassers + 5 ccm der Enzymlösung + 10ccm der Askorbinsäurelösung		0, 175 *100, 0	0, 173 *98, 8	0, 172 *98, 2	0, 168 *96, 0	7, 1°

*Prozent der gefundenen Askorbinsäuremenge zur initialen.

Askorbinsäurelösung: Etwa 88 mg „Ascoltin“ (Vitamin C-Arznei) wurde in 10 cc des dest. Wassers gelöst.

Enzymlösung wurde aus Kartoffeln, wie im Text, hergestellt.

Die Reagenzien, welche in dem dicken Reagenzrohr ohne Stöpsel gemischt waren, wurden im fliessenden Leitungswasser (7°-8°) gehalten. Zur Zeit der Bestimmung der Askorbinsäure wurde die Flüssigkeit daraus auspipettiert.

Aus diesen Ergebnissen geht hervor, dass 2 oder 1%ige Lösung der Metaphosphorsäure die Stabilität der Askorbinsäure am besten gewährleistet. Die dabei wiedergefundenen Askorbinsäuremengen sind nicht nur mehr als die bei den höheren Konzentrationen der Metaphosphorsäure, sondern auch als die beim destillierten Wasser gefundenen. Dies ist völlig im Einklang mit dem Ergebnisse ITOS ('38).

Nun wurde in bezug auf die Intensität der Enzymwirkung folgendes geprüft. Nachdem ein Gemisch von 5 ccm des Puffergemisches (pH=5,6), 10 ccm der Askorbinsäure und von 10 ccm der Enzymlösung hergestellt war, wurde es sofort ins Wasserbad (40°) gebracht. Nach 30 Minuten wurde der Verlust der Askorbinsäure bestimmt. Als Kontrolle wurde die 3 Minuten lang gekochte Enzymlösung angewandt.

Aus den Ergebnissen ist es festgestellt, dass 10 ccm Enzymlösung innerhalb 30 Minuten bei 40°C 0,247 mg der Askorbinsäure oxydieren können, was aus dem Verlust hervorgeht, der durch die Autooxydation der Askorbinsäure hervorgerufen wird. Daraus folgt, dass die Wirkungsintensität der in meinem Versuch angewandten Enzymlösung schwächer ist als die bei TAUBER und KLEINER ('35), da bei ihrem Versuch 0,5 mg der Askorbinsäure durch 10 ccm der Enzymlösung innerhalb 30 Minuten bei 38°C völlig oxydiert werden.

(2) *Stabilität der Askorbinsäure während der Herstellung des Auszugs.*

Bei der Herstellung des Auszugs der Askorbinsäure wird das Material nach Zerreiben in der 2%igen Metaphosphorsäurelösung 30 Minuten lang im Mörser auf dem Eis im Eisschrank gehalten. Es wird nun durch den Modellversuch geprüft, ob dabei die Oxydation der Askorbinsäure irgendwie stattfinden wird. Dazu wurden alle Reagenzien und der Mörser vorher im Eisschrank stehen gelassen, und 25 ccm Askorbinsäurelösung, 12,5 ccm 8%iger Metaphosphorsäurelösung und 12,5 ccm Enzymlösung im Mörser gemischt.

Die Ergebnisse sind in Tabelle 2 wiedergegeben.

TABELLE 2.
Stabilität der Askorbinsäure während der Herstellung des Auszugs

Zeit in Min.	0	20	40	60
Gefundene Askorbinsäure in mg/ccm	0, 173	0, 173	0, 173	0, 172
Temperatur des Gemisches (°C)	6, 5	4, 5	2, 5	2, 0

Man sieht, dass die Stabilität der Askorbinsäure in diesem Versuch befriedigend ist.

(3) *Stabilität der Askorbinsäure während der Vertreibung des reduzierend wirkenden H_2S aus dem Auszug mittels des N_2*

Bei der Reduktion der Dehydroaskorbinsäure durch H_2S, um die gesamte Askorbinsäuremenge zu bestimmen, muss man darauf achten, dass pH des sauren Auszugs von Askorbinsäure durch Natriumacetatlösung auf etwa 4,8 erhöht wird. Nun ist vielleicht zu befürchten, dass während der Vertreibung des H_2S mittels des N_2 eine gewisse Oxydation der Askorbinsäure durch die Luft oder die im Auszug sich befindende Askorbinsäureoxydase stattfindet. Um diese Frage klarzustellen, wurde ein Versuch ausgeführt.

Die Ergebnisse sind in Tabelle 3 wiedergegeben.

TABELLE 3.

Stabilität der Askorbinsäure während der Vertreibung von H_2S durch N_2

		Reagenzien	Behandlung	Gefundene Askorbinsäure
Kein Enzym zugestzt	A	20 ccm des Askorbinsäure-Metaphosphorsäuregemisches + 6,7 ccm des dest. Wassers (pH = 1,4)	Sofort nach Herstellung titriert	0,098 in mg/ccm von A
	B	10 ccm von A + 0,6 ccm der Na-Acetatlösung (pH = 4,8)	Durch H_2S 30 Min. lang reduziert, dann über Nacht gestanden, mit 10%iger Metaphosphorsäure voll auf 20 cc gemacht, dann H_2S durch N_2 vertrieben	Vertreibungsdauer: 1,5 Std. 2,0 Std. 0,112 0,112 in mg/ccm von A
Enzym zugesetzt	C	20 ccm des Askorbinsäure-Metaphosphorsäuregemisches + 6,7 ccm der Enzymlösung (pH = 1,4)	Sofort nach Herstellung titriert	0,098 in mg/ccm von C
	D	10 ccm von C + 0,25 ccm der 2 %igen KJ-Lösung + 0,25 ccm der 1/100 N-KJO_3-Lösung + 0,6 ccm der 50%igen Na-Acetatlösung (ph = 4,8)	Wie bei B behandelt	Vertreibungsdauer: 1,5 Std. 2,0 Std. 0,113 0,113 in mg/ccm von C
	E	Reagenzien ganz gleich wie bei D (pH = 4,8)	Sofort nach Herstellung mit 10 %iger Metaphosphorsäurelösung voll auf 20 ccm gemacht, danach titriert	0,077 in mg/ccm von C

Askorbinsäurelösung: 0,147 gr des „Askoltin" wurde in 30 ccm des dest. Wassers aufgelöst.

Askorbinsäure-Metaphosphorsäuregemisch: 15 ccm der 8%igen Metaphosphorsäurelösung wurden in 30 ccm der Askorbinsäurelösung zugesetzt.

Enzymlösung wurde wie vorhererwähnt hergestellt.

Es lässt sich nun daraus entnehmen, dass die Askorbinsäuremenge unabhängig vom etwaigen Vorhandensein der Oxydase oder von der Berührung mit der Luft beinahe dieselbe bleibt wie die der Kontrolle. Diese Ergebnisse führen uns zu dem Schluss, dass während der Vertreibung von

H_2S aus dem Auszug mittels des N_2 keine Oxydation der Askorbinsäure berücksichtigt zu werden braucht.

II. MATERIAL UND METHODIK

Das für die Untersuchungen verwandte Material stammte grösstenteils aus dem Baumschatten im Botanischen Garten dieses Institutes, im übringen wurde es aus den Hainen in der Nachbarschaft gesammelt.

Es wurde stets darauf geachtet, dass die Bestimmung der Askorbinsäure sofort nach dem Sammeln und in derselben Weise durchgeführt wurde, wie bei unserer vorangehenden Arbeit, d.h. mit Hilfe der Titrationsmethode nach TILLMANS, in der etwas verbesserten Form von OKUDA und KATAI ('39). Die im folgenden wiedergegebenen Askorbinsäurewerte sind auf das frische Gewicht bezogen.

III. ERGEBNISSE UND BESPRECHUNG

1. *Askorbinsäuregehalt der besonders gern im Schatten wachsenden Krautpflanzen.*

Die erhaltenen Ergebnisse sind in Tabelle 4 zusammengestellt.

TABELLE 4.

Askorbinsäuregehalt der Schattenkrautpflanzen

Pflanzen	Familie	Untersucht am	Gehalt in mg/gr, auf Frischgewicht			Menge redzierter Form / Gesamt-Menge (%)
			Red.	Oxyd.	Gesamt.	
Calonthe discolor LINDLEY	*Orchidaceae*	(1940) 1, 10	2, 469	0, 022	2, 491	99, 1
Zingiber Mioga ROSCOL	*Zingiberaceae*	19, 6	0, 515	0, 048	0, 563	91, 4
Iris gracilipes A. GRAY	*Iridaceae*	13, 6	1, 375	0, 013	1, 370	99, 0
Liriope muscari BAILEY var. *communis* NAKAI	*Ophiopogonaceae*	17, 9	0, 299	0, 049	0, 348	85, 9
L. gracilis NAKAI	,,	4, 10	0, 733	0, 172	0, 905	81, 0
Trillium Smalli MAXIMOWICZ	*Trilliaceae*	13, 6	0, 510	0, 092	0, 602	84, 6
Disporum sessile D. DON	*Convallariaceae*	1, 10	0, 330	0, 232	0, 562	58, 8
Smilacina japonica A. GRAY	,,	8, 6	0, 182	0, 252	0, 434	42, 0
Reineckia carnea KUNTH	,,	8, 10	0, 215	0, 043	0, 258	83, 4
Rhodea japonica ROTH	,,	23, 9	0, 547	0, 008	0, 555	98, 7
Cardiocrinum cordatum MAKINO	*Liliaceae*	19, 6	0, 047	0, 943	0, 990	4, 8
Lilium auratum LINDLEY	,,	8, 6	0, 130	0, 002	0, 132	98, 2
Allium victorialis LINNAEUS subsp. *platyphylum* HULTÉN.	*Alliaceae*	15, 6	0, 341	0, 110	0, 451	75, 6
Tricyrtis hirta HOOKER var. *parviflora* MASAMUNE	*Melanthaceae*	28, 9	0, 253	0, 137	0, 390	64, 8

Arisaema japonicum BLUME	*Araceae*	15,	6	0, 727	0, 051	0, 778	93, 4
A. robustum NAKAI	,,	21,	9	0, 462	0, 032	0, 494	93, 5
Carex lanceolata BOOTT	*Cyperaceae*	11,	10	0, 644	0, 098	0, 742	86, 8
Arthraxon hispidus MAKINO var. *brevisetus* HARA	*Poaceae*	19,	9	0, 216	0, 003	0, 219	98, 8
Oplismenus undulatifolius ROEMER et SCHULTES	,,	8,	10	0, 284	0, 204	0, 488	58, 1
Adenocaulon adhaerescens MAXIMOWICZ	*Asteraceae*	26,	9	0, 117	0, 041	0, 158	74, 4
Ainsliaea apiculata SCHULTZ-BIPONTINUS	,,	28,	9	0, 116	0, 169	0, 335	49, 5
Aster ageratoides TURCZANINOW supsp. *amplexifolius* KITAMURA	,,	13,	6	0, 166	0, 095	0, 211	54, 9
Macroclinidium trilobum MAKINO	,,	27,	9	0, 074	0, 257	0, 331	22, 3
Syneilesis palmata MAXIMOWICZ	,,	23,	10	0, 091	0, 285	0, 376	23, 9
Cacalia farfaraefolia SIEB. et ZUCC. var. *bulbifera* KITAMURA	,,	27,	6	—	0, 284	0, 284	. . .
Saussurea nipponica MIQUEL subsp. *sendaica* KITAMURA	,,	3,	10	0, 155	0, 143	0, 298	52, 0
Phryma leptostachya LINNAEUS	*Phrymaceae*	23,	10	0, 101	0, 158	0, 259	38, 8
Amethystanthus inflexus NAKAI	*Lamiaceae*	11,	10	0, 327	0, 183	0, 510	64, 1
Clinopodium anfine O. KUNTZE	,,	8,	10	0, 216	0, 287	0, 503	43, 0
Comanthosphace sublanceolate S. MOORE	,,	20,	9	0, 219	0, 145	0, 364	60, 2
Salvia nipponica MIQUEL form. *argutidens* MAKINO	,,	23,	10	0, 075	0, 115	0, 190	39, 2
Scutellaria laeteviolacea KOIDUMI	,,	4,	10	0, 667	0, 236	0, 903	73, 8
Tripterospermum japonicum MAXIMOWICZ	*Gentianaceae*	7,	10	0, 691	0, 120	0, 811	85, 2
Pirola japonica KLENZE	*Pirolaceae*	11,	10	0, 563	0, 190	0, 753	74, 8
Schizocodon uniflora MAXIMOWICZ	*Diapensiaceae*	4,	10	0, 858	0, 128	0, 986	87, 1
Angelica decursiva FRANCHET et SAVATIER	*Apiaceae*	11,	10	1, 366	0, 118	1, 484	92, 0
Anthriscus nemorosa SPRENGEL	,,	25,	9	0, 424	0, 162	0, 586	72, 3
Chamaele decumbens MAKINO	,,	8,	10	1, 082	0, 121	1, 203	90, 0
Hydrocotyle Wilfordi MAXIMOWICZ	,,	4,	10	0, 652	0, 140	0, 792	82, 3
Sanicula chinensis BUNGE	,,	27,	9	0, 278	0, 118	0, 396	70, 1
Viola nipponica MAXIMOWICZ	*Violaceae*	7,	10	0, 968	0, 107	1, 075	90, 1
V. odorata LINNAEUS	,,	29,	9	0, 691	0, 086	0, 777	88, 9
Impatiens Noli-tangere LINNAEUS	*Balsaminaceae*	13,	6	0, 624	0, 033	0, 657	95, 0
I. Textori MIQUEL	,,	26,	9	0, 364	0, 050	0, 414	87, 9
Epimedium cremeum NAKAI et F. MAEKAWA	*Berberidaceae*	1,	10	1, 179	0, 393	1, 572	75, 0
Coptis japonica MAKINO var. *dissecta* NAKAI	*Ranunculaceae*	7,	10	0, 760	0, 108	0, 868	87, 5
Kirengeshoma palmata YATABE	*Saxifragaceae*	14,	6	0, 430	0, 018	0, 448	95, 9
Saxifraga stolonifera MEERBURGH	,,	25,	9	0, 041	0, 014	0, 055	75, 0
Wasabia bracteata HISAUTI	*Brassicaceae*	1,	10	0, 339	0, 046	0, 385	88, 1
Cimicifuga acerina TANAKA var. *obtusiloba* NAKAI	*Ranunculaceae*	13,	6	0, 195	0, 567	0, 762	25, 6
Persicaria Posumbu GROSS	*Palygonaceae*	27,	9	0, 459	0, 047	0, 506	90. 6

Tovara filiformis NAKAI	*Polygonaceae*	21, 9	0, 244	0, 077	0, 321	76, 0
Begonia Evansiana ANDREWS (Topfkultur)	*Begoniaceae*	1, 10	0, 234	0, 044	0, 278	84, 2
Elatostema umbellatum BLUME var. *majus* MAXIMOWICZ	*Urticaceae*	8, 10	0, 288	0, 086	0, 374	76, 9
Pilea Hamaoi MAKINO	,,	8, 10	1, 042	0, 143	1, 185	88, 0
P. sp.	,,	26, 9	0, 422	0, 010	0, 432	97, 8
Urtica Thunbergiana SIEBOLD et ZUCCARINI	,,	17, 6	1, 488	0, 112	1, 600	93, 0
Tricercandra japonica NAKAI	*Chloranthaceae*	17, 6	0, 201	0, 298	0, 499	40, 2
Polypara cordata BUECK	*Saururaceae*	25, 6	0, 334	0, 061	0, 395	84, 5
Lycopodium clavatum LIMAEUS var. *nipponicum* NAKAI	*Lycopodiaceae*	7, 10	0, 249	0, 083	0, 332	75, 0
L. serratum THUNBERG var. *javanicum* MAKINO	,,	7, 10	0, 241	0, 084	0, 325	74, 2
Equisetum hyemale LINNAEUS var. *japonicum* MILDE	*Equisetaceae*	30, 9	0, 175	0, 107	0, 282	62, 1
Osmunda japonica THUNBERG	*Osmundaceae*	27, 9	0, 271	0, 049	0, 320	84, 6
Spicantopsis nipponica NAKAI var. *japonica* NAKAI	*Polypodiaceae*	11, 10	0, 262	0, 088	0, 350	74, 8

Aus Tabelle 4 ersieht man, dass im allgemeinen die gern im Schatten wachsenden Pflanzen, welche ebenfalls in unserer vorhergehenden Arbeit grösstenteils untersucht wurden, einen geringeren Gesamtgehalt an Askorbinsäure als die Sonnenpflanzen aufweisen. Der Mittelwert betrug für die Schattenpflanzen 0,63±0,038 mg/gr und für die Sonnenpflanzen 1,28±0,086 mg/gr. Dieser deutliche Unterschied bekräftigt die Annahme, dass sich die Schattenpflanze gegenüber der Sonnenpflanze durch ihren geringeren Gehalt an Askorbinsäure kennzeichnet.

Von den gern im Schatten wachsenden Pflanzen ist der gesamte Gehalt an Askorbinsäure in den folgenden Pflanzen verhältnismässig hoch gefunden worden:

	(mg/gr)
Galontha discolor LINDLEY	2,491
Urtica thunbergiana SIEBOLD et ZUCCARINI	1,600
Epimedium cremeum NAKAI et F. MAEKAWA	1,572
Angelica decursiva FRANCHET et SAVATIER	1,484

Dagegen in den folgenden wurde er am geringsten gefunden:

Saxifraga stolonifera MEEBURGH	0,055
Lilium auratum LINDLEY	0,132
Adenocaulon adhaerescens MAXIMOWICZ	0,158
Salvia nipponica MIQUEL form. *argutidens* MAKINO	0,190

Bemerkenswert ist es, dass sich bei *Cacalia farfaraefolia* SIEB. et ZUCC. var. *bulbifera* KITAMURA keine nennenswerte reduzierte Form der Askorbinsäure, sondern nur die Dehydroform findet, wie schon in unserem vorangehenden Versuch beobachtet wurde. Unerwartet ist auch der Fall von

Cardiocrinum cordatum MAKINO, bei welchem die Askorbinsäure sich grösstenteils in der oxydierten Form findet. Im Gegensatz dazu kommt sie bei *Calonthe discolor* LINDLEY, *Iris gracilipes* A. GRAY, *Arthraxon hispidus* MAKINO var. *brevisetus* HARA und *Rhodea japonica* ROTH überwiegend in der reduzierten Form vor.

Betreffs des Verhältnisse der Menge der reduzierten Form zur gesamten kommt bei der Schattenpflanze verhältnismässig häufig ein geringer Wert vor. Ob dies immer bei den Schattenpflanzen der Fall ist, kann aber nicht ohne weiteres gesagt werden. Es kommt nämlich oft vor, dass er auch bei der Schattenpflanze gross ausfällt, weil die Askorbinsäure grösstenteils in der reduzierten Form vorkommt. Der Mittelwert des Verhältnisses betrug für Schattenpflanzen 74,2±2,84% und für Sonnenpflanzen 75±2,50%.

Dass die reversibel oxydierte Askorbinsäure, d.h. Dehydroaskorbinsäure, ebenso als Vitamin-C wirksam ist, ist von vielen Forschern bestätigt worden (HIRRT und ZILVA '33, FOX und LEVY '36, BORSOOK, DAVENPORT, JEFFERRYS und WARNER '37 u.s.w.) FUJITA und EBIHARA ('37) berichteten, dass bei Gemüsen und Obst häufig die ganze Menge oder der grösste Teil der Askorbinsäure in der Dehydroform vorliegt, zum Beispiel wie bei Fällen von Paprika, Gurken, Melonen und Bananen. In unserem Versuche kam es ebenfalls bei einigen Fällen so vor. Dies war aber MOLDTMANN ('39) entgangen, sodass er vielmehr annahm, dass in den meisten pflanzlichen Organen der Gehalt an Dehydroaskorbinsäure zu vernachlässigen sei. Trotzdem beobachtete BUKATSCH ('40) abermals, dass bei *Elodea* fast keine reduzierte Form, sondern hauptsächlich Dehydroform vorkommt.

Um diese Sachlage klarzustellen, ist es wünschenswert, eine weitere ausführliche Untersuchung vorzunehmen.

2. *Veränderungen des Askorbinsäuregehaltes bzw. des Mengeverhältnisses zwischen der reduzierten und oxydierten Form in Abhängigkeit von den Lichtfaktoren.*

Es scheint mir von Bedeutung, kennen zu lernen, ob das Mengeverhältnis zwischen der reduzierten und oxydierten Form der Askorbinsäure eine veränderliche Beschaffenheit aller Pflanzen ist oder nicht. Es is natürlich darauf zu achten, dass das Licht eine wichtige Rolle in dieser Richtung spielt. Um diese Frage klarzustellen, wurde die Untersuchung wie folgt vorgenommen.

Als Material wurden verwendet: *Hosta Sieboldiana* ENGLER, *Cacalia farfaraefolia* SIEB. et ZUCC. var. *bulbifera* und *Begonia Evansiana* ANDREWS, die alle als Topfkulturen gezogen wurden. Die erstere gehört zu den

Sonnen- und die letzteren zwei zu den Schattenpflanzen. Vor dem Versuch liess man diese Topfkulturpflanzen da stehen, wo sie üppig wachsen konnten, und zwar stand die erstere im Sonnenlicht und die letzteren zwei im Schatten. Zur Kontrolle fanden sie sich weiter in den genannten normalen Bedingungen, während die Versuchspflanzen unter den umgekehrten standen, sodass die Sonnenpflanze im Schatten stehen gelassen wurde und umgekehrt. Nach dem Verbleiben unter den genannten Umgebungen wurde die Bestimmung der Askorbinsäure vorgenommen.

Die erhaltenen Ergebnisse sind in Tabelle 5 wiedergegeben.

TABELLE 5.

Veränderungen des Askorbinsäuregehaltes bzw. des Mengeverhältnisses zwischen der reduzierten und der oxydierten Form in Abhängigkeit von den Lichtfaktoren

Pflanzen	Datum (1940)	Sonnenlicht				Schatten			
		Askorbinsäuregehalt (mg/gr)			$\frac{\text{Menge reduzierter Form}}{\text{Gesamtmenge}}$ (%)	Askorbinsäuregehalt (mg/gr)			$\frac{\text{Menge reduzierter Form}}{\text{Gesamtmenge}}$ (%)
		Red.	Oxyd.	Gesamt.		Red.	Oxyd.	Gesamt.	
Hosta Sieboldiana	7, 6	1, 860	0, 139	1, 999	93, 0	1, 363	0, 035	1, 398	97, 5
	14, 6	2, 066	0, 037	2, 103	98, 2	1, 511	0, 002	1, 513	98, 9
	21, 6	2, 634	0, 100	2, 734	96. 3	1, 240	0, 022	1, 262	98, 2
	28, 6	2, 188	0, 001	2, 189	99, 9	1, 261	0, 002	1, 263	99, 8
	5, 7	2, 365	0, 025	2, 390	98, 9	0, 575	0, 051	0, 626	91, 1
	12, 7	2, 256	0, 024	2, 280	98, 9	0, 646	0, 002	0, 648	99, 7
	22, 7	1, 954	0, 026	1, 980	98, 7	0, 189	0, 015	0, 204	92, 5
	1, 10	1, 226	0, 015	1, 241	98, 9	0, 389	0, 032	0, 421	92, 4
Begonia Evansiana	11, 7	0, 095	0, 024	0, 119	79, 7	—	—	—	—
	1, 10	0, 397	0, 089	0, 486	81, 7	0, 234	0, 044	0, 278	84, 2
Cacalia farfaraefolia var. *bulbifera*	27, 6	—	0, 225	0, 225	—	—	0, 284	0, 284	—
	11, 7	0, 153	0, 421	0, 574	26, 7	—	—	—	—
	1, 10	0, 254	0, 401	0, 655	38, 8	—	—	—	—

Aus diesen Ergebnissen geht hervor, dass bei *Hosta Sieboldiana* der Askorbinsäuregehalt der im Schatten gezogenen Pflanzen allmählig abnahm und nach etwa anderthalb Monaten den Mindestwert erreichte. Betreffs des Mengeverhältnisses der beiden Askorbinsäureformen lag kein wesentliche Unterschied vor zwischen den im Schatten und im Sonnenlicht gezogenen Pflanzen, abgesehen von mehr oder weniger grossen Schwankungen. Bei den eigentlichen Schattenflanzen wie *Begonia Evansiana* und *Cacalia farfaraefolia* nahm dagegen der Askorbinsäuregehalt der im Sonnenlicht gezogenen Pflanzen mit der Zeit ziemlich zu. Das Mengeverhältnis zwischen den beiden Askorbinsäureformen bei *Begonia Evansiana* bleibt beständig, während es bei *Cacalia farfaraefolia* im Verlauf der Zeit ansteigt. Nach ZILVA, KIDD und WEST ('38) kommt die Askorbinsäure im Apfel stets in den beiden Formen vor. Das Mengeverhältnis beider Formen bleibt im Verlauf der Fruchtentwicklung unverändert, erst bei erreichtem Reifezustand des Apfels verschiebt sich das Verhältnis zugunsten der reduzierten Form.

3. *Der Askorbinsäuregehalt der panaschierten Pflanzen.*

Der Askorbinsäuregehalt der panaschierten Pflanzen wurde von MOLDTMANN ('39) und ferner BUKATSCH ('40) im Himblick auf die Abhängigkeit des Askorbinsäuregehalts von der Menge des in den Pflanzen vorhandenen Chlorophylls untersucht, mit dem Ergebnisse, dass die blassen Teile weniger Askorbinsäure als die grünen enthalten. WEBER ('40) beobachtete auch den Askorbinsäuregehalt von Albinos und panaschierten Pflanzen.

Unsere Versuche führten zu folgendem Ergebnis.

TABELLE 6.

Askorbinsäuregehalt der panaschierten Pflanzen

Pflanzen	Untersuchter Teil	Askorbinsäure in mg/gr			Menge reduzierter Form / Gesamt. (%)
		Red.	Oxyd.	Gesamt.	
Hemerocallis fulva var. *longituba*	Weisse Blätter	0, 028	0, 002	0, 030	93, 9
	Grüne Blätter	1, 486	0, 046	1, 532	96, 9
,,	Weisser Teil	0, 865	0, 019	0, 884	97, 9
	Grüner Teil	1, 626	0, 078	1, 704	95, 4
Pelargonium zonale	Weisser Teil	0, 256	0, 054	0, 310	82, 8
	Grüner Teil	0, 431	0, 065	0, 496	86, 9
Chlorophytum elatum	Weisser Teil	0, 257	0, 112	0, 369	69, 6
	Grüner Teil	0, 746	0, 185	0, 931	80, 0

Wie aus Tabelle 6 zu ersehen ist, enthalten die weissen Teile weniger Askorbinsäure als die grünen, was vollständig mit den Ergebnissen von MOLDTMANN und BUKATSCH übereinstimmt. Es wird mit grossem Interesse verfolgt, dass die Blätter auch der Pflanze, deren ganzer Körper weiss ist, Askorbinsäure enthalten. Es bleibt aber zu untersuchen, woher die dabei nachgewiesene Askorbinsäure stammt, namentlich ob sie von der Wurzel, von der aus sich auch der Grünteil entwickelt, oder von den Produkten des Stoffwechsels, welche im weissen Blatt vor sich geht, stammt.

Weiter ersieht man, dass bei *Hemerocallis* der grösste Teil der Askorbinsäure in der reduzierten Form vorliegt, während bei *Pelargonium* und

Chlorophytum die Dehydroform noch mässig vorhanden ist. Trotz alledem bleibt die Verhältniszahl der Menge der reduzierten Form zur gesamten der Askorbinsäure beinah dieselbe sowohl bei den weissen als bei den grünen Teilen derselben Pflanzen.

ZUSAMMENFASSUNG

1. Einige Nachprüfungen der Bestimmungsmethode für die Askorbinsäure wurden ausgefühurt.

2. Der Askorbinsäuregehalt der gern im Schatten wachsenden Krautpflanzen wurde bestimmt.

3. Im Vergleich mit den Sonnenpflanzen weisen die Schattenpflanzen im allgemeinen einen geringeren Askorbinsäuregehalt auf.

4. Betreffs des Verhältnisses zwischen der Menge der reduzierten Form zur Gesamtmenge steht verhältnismässig häufig der geringe Wert bei den Schattenpflanzen. Es bleibt noch zu untersuchen, ob dies bei den Schattenpflanzen immer der Fall ist.

5. Das Mengeverhältnis der beiden Askorbinsäureformen bei *Hosta* und *Begonia* verändert sich nicht wesentlich im Sonnenlicht und im Schatten, bei *Cacalia* neigt es im Sonnenlicht etwas dazu anzusteigen.

6. Auch in chlorophyllfreien Blättern und Pflanzenteilen der panaschierten Pflanzen wird Askorbinsäure und auch ihre Dehydroform nachgewiesen.

Zum Schluss sei es mir erlaubt, Herrn Prof. Dr. Y. YAMAGUTI meinen herzlichsten Dank für alle wertvollen Ratschläge und für liebenswürdige Revision dieser Arbeit auszusprechen. Gleichzeitig fühle ich mich Herrn ausserordentlichem Prof. Dr. T. KOIZUMI, der die Ausführung dieser Arbeit unermüdlich leitete, zu grösstem Danke verpflichtet, für all Freundlichkeiten und alle Anregungen während meiner Arbeiten.

LITERATURVERZEICHNIS

BORSOOK, H., H. W. DAVENPORT, C. E. R. JEFFEREYS and R. C. WARNER, (1937). The oxidation of ascorbic acid and its reduction in vitro and in vivo. J. biol. Chem., **117**, 237.

BUKATSCH, F., (1940). Über die Rolle der Askorbinsäure in den Chloroplasten. II. Mitt., Planta, **31**, 209.

FOX, F. S. and L. F. LEVEY, (1936). Experiments confirming the ascorbutic activity of dehydroascorbic acid and a study of its storage and that of ascorbic acid by the gunea-pig at different levels of intake. Biochem. J., **30**, 221.

FUJITA, A. und D. IWATAKE, (1935). Über die Bestimmung von Vitamin-C mittels 2, 6-Dichlorophenol-Indophenol. Biochem. Z., **277**, 293.

FUJITA, A. und T. EBIHARA, (1927). Über die Verteilung des Vitamin-C in tierischen und pflanzlichen Geweben. I. Biochem. Z., **290**, 201.

HARRIS, L. J. and S. H. RAY. (1933). Vitamin-C and the suprarenal cortex. II. Loss of potency of gunea-pig suprarenals in scurvy. With notes on a method for determining antiscorbutic activity (hexuronic acid) by chemical means. Biochem. J., **27**, 303.

HIRST, E. L. und S. S. ZILVA, (1933). Ascorbic acid as the antiscorbutic factor. Biochem. J., **27**, 1271.

ITO, N., (1938). Studies on ascorbic acid oxidase. I. (Japanisch mit englichem Auszug). Bull. Agr. Chem. Soc. Japan., **14**, 140.

KOIZUMI, T. and T. KAKUKAWA, (1940). On the vitamin-C (ascorbic acid) content of herbaceous plants and marine algae, considering factors influencing it. Sci. Rep. Tôhoku Imp. Univ., Biol., **15**, 105.

MIWA, H., (1938). Untersuchungen über die Hilfsquellen von Vitamin-C. I. Über den Vitamin-C-Gehalt der Blumen und der Blätter von der verschiedenen Pflanzen. (Japanisch). Jôzôgaku-Zassi, **16**, 581.

——, (1938). Der Vitamin-C-Gehalt der jungen Baumblätter im Frühsommer. (Japanisch). Ebenda, **16**, 716.

——, (1938). III. Über den Vitamin-C-Gehalt der Krautpflanzen. (Japanisch). Ebenda, **16**, 789.

——, (1938). IV. Der Vitamin-C-Gehalt der Baumblätter im Sommer. (Japanisch). Ebenda, **16**, 937.

——, (1939). V. Über den Vitamin-C-Gehalt der Krautpflanzen (Aug.-Okt.). (Japanisch). Ebenda, **17**, 33.

——, (1939). VI. Über den Vitamin-C-Gehalt der Krautpflanzen (Sept.-Okt.). (Japanisch). Ebenda, **17**, 177.

——, (1939). VII. (Japanisch). Ebenda, **17**, 579.

MOLDTMANN, H. G., (1939). Untersuchungen über den Askorbinsäuregehalt der Pflanzen in seiner Abhängigkeit von inneren und äusseren Faktoren. Planta, **30**, 297.

OKUDA, Y. and K. KATAI, (1939). Biochemical investigation of mosaic disease of tobacco plants V. On the ascorbic acid content in the leaves of healthy and mosaic plants. (Japanisch). Bull. Agr. Chem. Soc. Japan, **15**, 80.

OTT, M., (1941). Spezifische Vitamin-C-Bestimmung. Angew. Chem., 13/14, 170.

SAITO, M. and M. WATANABE, (1939). Studies on wild grasses of Manchoukuo as fodder plants. I. (Japanisch). Rep. Ins. Sci. Res. Manchoukuo, **3**, 39.

TAUBER, H. and I. S. KLEINER, (1935). An enzymic method for the estimation of true vitamin-C. J. of Biol. Chem., **110**, 559.

TILLMANS, J., (1930). Das antiskorbutische Vitamin. Z. Untrs. Lebesm., **60**, 34.

WEBER, N., (1940). Vitamin-C-Gehalt von Albinos und panaschierten Pflanzen. Protoplasma, **35**, 136.

ZILVA, S. S., F. KIDD and C, WEST, (1938). Ascorbic acid in the metabolism of the apple fruit. New Phytologist, **37**, 345.

SCHWANKUNGEN DES GEHALTS AN ASKORBINSÄURE UND KOHLENHYDRATEN IN PFLANZENBLÄTTERN WÄHREND DER VERSCHIEDENEN TAGESZEITEN

VON

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(Mit 1 Abbildung)

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GIROUD und seine Mitarbeiter ('34, a, b, '35, '38) stellten auf Grund ihrer Untersuchungen fest, dass ein enger Zusammenhang zwischen dem Askorbinsäure- und dem Chlorophyllgehalt besteht. Diese Anschauung wurde danach von zahlreichen Forschern (DISCHENDORFER '37, ASIKAGA '38, WEIER '38, PEKAREK '38, NEUBAUER '39, MOLDTMANN '39, BUKATSCH '39, '40 u. s. w.) bestätigt. GIROUD ('38) äusserte, dass in der grünen Pflanze bei der Umwandlung von Kohlensäure in Kohlenhydrat sehr wahrscheinlich der Askorbinsäure eine aktive Beteiligung zukomme. BUKATSCH ('39) beobachtete, dass durch Zufuhr von Askorbinsäure von aussen Assimilationssteigerung der Wasserpflanzen hervorgerufen wurde und der qualitative Aldehydnachweis im Modellversuch (Kolophonium- oder Lecithinsol + Chlorophyll + Askorbinsäurelösung) im Sinne der BAURschen Ansicht ('32, '35, '37 a, b, c.) erbracht werden konnte. Aus diesen Tatsachen kam er zu dem Schluss, dass Askorbinsäure aktiv am Mechanismus der CO_2-Reduktion beteiligt sei.

In den letzten Jahren sind allerdings Arbeiten veröffentlicht worden, die sich gegen eine Verallgemeinerung dieser Relation zwischen Askorbinsäure und Chlorophyll aussprechen. Im Gegensatz zu GIROUD findet zwar MIRIMANOFF ('38), dass zwischen dem Gehalt eines Organes an Askorbinsäure und dem an Chlorophyll bzw. Karotinoiden keine direkte Beziehung besteht. ERTL ('39) gab eine Stütze für die Ansicht von MIRIMANOFF an, wonach für die Silbernitrat-Reduktion durch die Plastiden das Chlorophyll als Sensibilator nötig sei, als Reduktor aber die Glukose. HAMDALLAE ('38) weist auf Grund seiner Versuche mit chlorotischen Pflanzen darauf hin, dass die Annahme eines Zusammenhanges zwischen beiden Stoffen nicht verallgemeinert werden dürfe. Nach WEBER ('40, a) enthalten die durch niedere Temperatur im Licht am Ergrünen verhinderten, karotinoidreichen

Keimlinge mehr Askorbinsäure als die nach gleich langer Belichtung bei Zimmertemperatur ergrünten.

SUGAWARA ('39) hat nach seinen Versuchen mit verschiedenen Lichtintensitäten einen Zusammenhang zwischen Photosynthese und Askorbinsäurebildung angenommen. WEISSENBÖCK ('40) berichtete, dass an sich keine direkte Beziehung zwischen Askorbinsäurebildung und dem Prozess der Photosynthese bestehe, d. h. Askorbinsäure demnach kein ummittelbares Assimilationsprodukt darstelle, doch vermutet er, dass eine Relation zwischen Glukose- und Askorbinsäuregehalt besteht. Aus den Untersuchungen der letzten Jahre wurde es aber wahrscheinlich gemacht, dass Askorbinsäure in den Pflanzen durch Umbau aus Kohlenhydraten entsteht; dafür spricht die Entstehung der Askorbinsäure in noch nicht assimilierenden Keimlingen. In bezug auf die Beziehung zwischen Askorbinsäure und Assimilaten wurde von MOLDTMANN ('39) bei Blättern monokotyler Pflanzen gefunden, dass je mehr Askorbinsäure eine Pflanze ausweist, um so grösser auch die in ihr vorkommende Menge von Glukose ist. Nach ihm verlaufen die Schwankungen im Askorbinsäuregehalt der Blätter von *Fagus silvatica* und *Lamium album* periodisch mit dem Wechsel zwischen Tag und Nacht. Und zwar folgt einem Anstieg während des Tages ein Sinken während der Nacht. Die Maxima liegen ungefähr in der Mittagszeit oder in den Nachmittagsstunden.

Um zur Feststellung dieser Frage etwas beizutragen, wurde ein Versuch über etwaige wechselseitige Schwankungen im Askorbinsäure- und Kohlenhydratgehalt während verschiedener Tageszeiten angestellt.

MATERIAL UND METHODIK

Für die Untersuchungen wurden Blätter der *Cucurbita moschata* DUCH. var. *toonas* MAKINO aus dem Botanischen Garten des Institutes verwendet. Es war darauf zu achten, dass alle Blätter möglichst denselben Belichtungs- und Ernährungsbedingungen ausgesetzt waren.

Die Bestimmung der Askorbinsäure in reduzierter Form und in ihrer gesamten Menge wurde in gleicher Weise wie bei unserer vorhergehenden Arbeit (KOIZUMI und KAKUKAWA '40) durchgeführt. Zur Bestimmung des reduzierenden Zuckers und der Stärke wurden je 5 gr frischen Blattmaterials mit 95%igem Alkohol extrahiert. Die Extraktion des reduzierenden Zuckers und die Hydrolyse der Stärke wurden mit den offiziellen Methoden, welche von A. O. A. C. (Methods of Analysis of the Association of Official Agricultural Chemists, 4th edition, 1935) empfohlen wurden, ausgeführt. Sowohl der reduzierende als auch der von Hydrolyse entstandene Zucker wurden jodometrisch durch die HAGEDORN–JENSENsche Methode bestimmt. Die Askorbinsäure, die Kohlenhydrate und der Wassergehalt wurden nebeneinander an demselben Blatt bestimmt.

ERGEBNISSE UND BESPRECHUNG

Vor dem Versuch muss allerdings geprüft werden, ob der gleichzeitig bestimmte Askorbinsäuregehalt bei verschiedenen Blättern der gleichen Pflanze, welche beinahe denselben Belichtungs- und Ernährungsbedingungen ausgesetzt waren, etwa gleichgestellt werden kann. Dazu wurden drei Bestimmungen durchgeführt. Die Ergebnisse sind in Tabelle 1 wiedergegeben.

TABELLE 1.

Blätter	Askorbinsäure in mg/gr auf Frischgewicht		
	Reduzierte	Oxidierte	Gesamtmenge
A	1,850	0,103	1,953
B	1,819	0,152	1,972
C	1,850	0,168	2,018

Aus diesen Ergebnissen geht hervor, dass der Askorbinsäuregehalt der Blätter der gleichen Pflanze bei den obengenannten Bedingungen nicht immer ganz genau übereinistimmt. Doch die hier gefundenen Abweichungen sind so klein, dass wir sie vernachlässigen können.

TABELLE 2.

Schwankungen des Gehalts an Askorbinsäure und Kohlenhydraten in Pflanzenblättern, *Cucurbita moschata* var. *toonas*, während der verschiedenen Tageszeiten

Zeit in Uhr	Askorbinsäure in mg/gr. auf Frischgewicht			Reduzierte Form / Gesamtmenge (%)	Stärke in %		Reduzierender Zucker in %		Wasser in %
	Red.	Oxid.	Gesamt.		auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht	
8	1,064	0,279	1,343	79,2	1,79	8,68	0,142	0,688	79,3
10	1,296	0,098	1,394	93,0	2,53	10,82	0,184	0,786	76,6
12	1,316	0,098	1,414	93,0	3,49	13,77	0,240	0,947	74,6
14	1,487	0,199	1,686	88,2	3,33	12,84	0,229	0,880	74,0
16	1,531	0,070	1,601	95,6	4,23	14,94	0,209	0,737	71,7
18	1,223	0,134	1,357	98,5	3,62	13,30	0,164	0,602	72,8
20	1,247	0,117	1,364	91,4	3,23	11,23	0,144	0,500	71,3
22	0,984	0,157	1,141	86,3	2,51	12,70	0,113	0,573	80,3
24	1,158	0,158	1,316	88,0	2,97	12,21	0,126	0,518	75,7
2	0,984	0,117	1,101	89,4	1,77	8,99	0.101	0,516	80,3
4	1,109	0,094	1,203	92,2	1,85	7,60	0,132	0,542	75,7
6	1,077	0,077	1,154	93,3	1,87	9,29	0,121	0,600	79.8

Nach dieser Prüfung der Versuchsmethode wurden die Untersuchungen über die Mengeverhältnisse zwischen der Askorbinsäure und dem Kohlenhydrate vorgenommen. Die Versuchsergebnisse sind in Tabelle 2 und in Abb. 1 wiedergegeben.

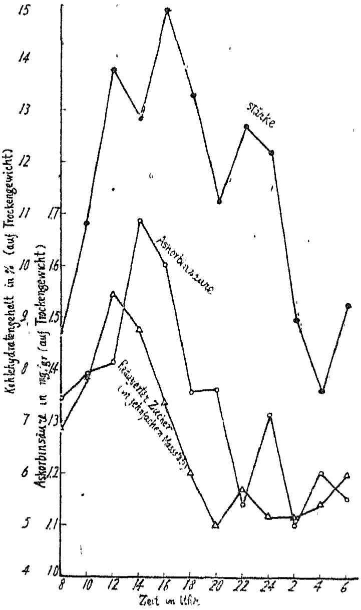

Abb. 1. Schwankungen im Askorbinsäure- und Kohlenhydratgehalt in Pflanzenblätter, *Cucubita moschata* var. *toonas*, während verschiedenen Tageszeiten.

Dieser Versuch wurde am 6. August. 1940, ausgeführt und das Wetter war den ganzen Tag herrlich.

Aus diesen Ergebnissen ist ersichtlich, dass die Askorbinsäure in der Mittagszeit, ungefähr um 14 Uhr, einen maximalen Anstieg vollzieht und dann gegen Abend hin wieder abnimmt. Sie stehen in völligem Einklang mit denen von MOLDTMANN ('39). Er nahm zwar naheliegend an, dass infolge zunehmender Intensität des Sonnenlichtes und damit verbundener Assimilationssteigerung im Laufe des Tages auch die Bildung der Askorbinsäure gefördert wird, und dass sie dann bei nachlassender Lichtintensität gegen Abend hin wieder abnimmt. Ein gewisser Parallelismus zwischen dem Askorbinsäure- und dem Assmilationsproduktgehalt auch in meinem Versuch lässt diese Annahme als höchst wahrscheinlich erscheinen. Betreffs des Gehalts an Stärke und reduzierendem Zucker sind die Maxima von denen beim Askorbinsäuregehalt etwas verschoben und zwar für die Stärke um 16 Uhr und für den reduzierenden Zucker um 12 Uhr. MOLDTMANN ('39) ist der Ansicht, dass für die Bildung der Askorbinsäure aller Wahrscheinlichkeit nach die bei der Photosynthese gebildete Glukose massgebend sei. SUGAWARA ('39), wie in der Einleitung erwähnt wurde, nahm einen Zusammenhang zwischen Photosynthese und Askorbinsäurebildung an. WEISSENBÖCK ('40) sah, dass auch bei normal grünen Pflanzen der assimilatorische Vorgang an sich für die Bildung von Vitamin-C nicht erforderlich ist, wohl aber eine gewisse Menge von Kohlenhydraten. Ob letztere nun durch die Assimilation täglich neu geliefert werden oder in Form von Reservestoffen vorhanden sind, bleibt für die Askorbinsäurebildung nebensächlich. Nach ihm stellt die Askorbinsäure kein unmittelbares Assimilationsprodukt dar; es ist vielmehr eine Relation zwischen Glukose- und Askorbinsäuregehalt wahrscheinlich. WEISSENBÖCK und NEUBAUER ('40) bereits beobachteten, dass kein Parallelismus zwischen der Chlorophyllentstehung und dem Askorbinsäuregehalt bestand. REID ('38) berichtete, dass die Zugabe von Kohlenhydrat in Form von Glukose den Gehalt an Askorbinsäure in den Pflanzen steigere. Aus MOLDTMANNS ('39) Befunden ist weiter ersichtlich, dass durch eine Zufuhr von organischen Substanzen, die die Stärke in den Pflanzen anzureichern vermag, sowohl der Gehalt an Glukose, Glyzerin und Saccharose, als auch der an Askorbinsäure erhöht wird. RAY ('33) berichtete, dass bei der Keimung die Hexose, wie die Glukose durch den Keimling, in Askorbinsäure umgesetzt werden könne.

Aus diesen Tatsachen wäre man berechtigt anzunehmen, dass der tägliche Rhythmus des Askorbinsäuregehaltes der Pflanzenblätter, denen von den Reservestoffbehältern her keine Zuckerarten zufliessen, von den daselbst entstehenden Assimilaten abhänge und der eigentliche Vorgang der Photosynthese an sich für die Bildung der Askorbinsäure nebensächlich sei.

ZUSAMMENFASSUNG

1. Der Gehalt der Blätter von *Cucurbita moschata* DUCH. var. *toonas* MAKINO an Askorbinsäure, Kohlenhydraten, u. a. an Stärke und reduzierendem Zucker wurde nebeneinander während verschiedener Tageszeiten bestimmt.

2. Die Schwankung im Askorbinsäuregehalt verläuft parallel mit dem Tageswechsel. Das Maximum liegt ungefähr in der Nachmittagszeit, um 14 Uhr.

3. Auch der Gehalt an Stärke und reduzierendem Zucker schwankt beinahe parallel zum Askorbinsäuregehalt. Aber die Maxima verschieben sich etwas von denen beim Askorbinsäuregehalt.

Herrn Prof. Dr. Y. YAMAGUTI bin ich für seine wertvollen Ratschläge und für liebenswürdige Revision dieser Arbeit zu grösstem Danke verpflichtet.

Auch möchte ich hier Herrn ausserordentlichem Prof. Dr. T. KOIZUMI, mit dessen Unterstützung diese Arbeit durchgeführt wurde, meinen herzlichsten Dank für alle Freundlichkeit aussprechen.

LITERATURVERZEICHNIS

ASIKAGA, M., (1938). Untersuchungen über die Askorbinsäure in Zuckerrohr. (Japanisch). J. Soc. Trop. Agr., **10**, 412.

BAUR, E., (1932). Desensibilatoren, Antioxygene und Antifluorescenten. Z. physik. Chem., **16**, 465.

——, (1935). Über eine photochemische Reaktion von Chlorophyll. Helvet. chim. Acta, **18**, 1157.

——, (1937, a). Über den Verlauf der Photolyse der Kohlensäure. Ebenda, **20**, 387.

—— und H. FRICKER, (1937, b). Über die photolytische Bildung von Formaldehyd aus Chlorophyll und Eosin. Ebenba, **20**, 391.

—— und K. GLOOR, (1937, c). Über die photolytische Bildung von Formaldehyd in der Eosingruppe. Ebenda, **20**, 970.

BUKATSCH, F., (1939). Über die Rolle der Askorbinsäure in den Chloroplasten. Planta, **30**, 118.

——, (1940). Über die Rolle der Askorbinsäure in den Chloroplasten. II. Mitt. Ebenda, **31**, 209.

DISCHENDORFER, O., (1937). Über den histochemischen Nachweis von Vitamin C (l-Askorbinsäure) in Pflanzen. Protoplasma, **28**, 516.

ERTL, O., (1939). Über die Silbernitrat-Reduktion der Plastiden. Ebenda, **33**, 275.

GIROUD, A., C. P. LEBLOND und R. RATSIMAMANGA, (1934, a). Significantion de la reduction des sels d'argent au niveau des plastes chlorophylliens. C. r. Soc. Biol., Paris, **117**, 614.

——, R. RATSIMAMANGA und C. P. LEBLOND, (1934, b). Parallélisme entre la vitamine C et la chlorophylle. Ebenda, **117**, 612.

——, —— und ——, (1935). Relations entre la vitamine C et les carotinoides. Ebenda, **118**, 874.

——, (1938). L'acid ascorbique dans la cellule et les tissus. Protoplasma Monographien, Berlin, **16**.

HAMDALLAH, ABU EL WAFA, (1939). Vitamin C-Gehalt Eisen- bzw. Magnesium-frei gezogener Pflanzen. Protoplasma, **32**, 31.

KOIZUMI, T. and T. KAKUKAWA, (1940). On the vitamin-C (ascorbic acid) content of harbaceous plants and marine algae, considering factors influencing it. Sci. Rep. Tôhoku Imp. Univ., Biol., **15**, 105.

MIRIMANOFF, A., (1938). Vitamin C et chlorophylle. C. r. Acad. Sci., Paris, **206**, 766.

——, (1938). Acid ascorbique et pigments caroténoides. Signification de le réaction de MOLISCH et essai de localisation de l'acide ascorbique. C. r. Acad. Sci., Paris, **206**, 1038.

MOLDTMANN, H. G., (1939). Untersuchungen über den Askorbinsäuregehalt der Pflanzen in seiner Abhängigkeit von inneren und äusseren Faktoren. Planta, **30**, 297.

NEUBAUER, M., (1939). Das Vitamin C in der Pflanze. Protoplasma, **33**, 345.

PEKAREK, J., (1938). Die Lokalisation des Silbernitrat-Reduktions in den Chloroplasten. Ebenda, **30**, 534.

REID, M. E., (1938). The effect of light on the accumulation of ascorbic acid in young copea plants. Amer. J. Bot., **25**, 701.

—— und R. L. WEINTRAUB, (1939). Synthesis of ascorbic acid in excised roots of the white moon flower. Science, (1939), **1**, 587.

SUGAWARA, T., (1939). Studies on the formation of ascorbic acid (vitamin C) in plants. I. The influence of light on the ascorbic acid contents in various etiolated seedlings. Jap. J. Bot., **10**, 141.

WEIER, B., (1938). Factors affecting the reduction of silber nitrate by chloroplasts. Amer. J. Bot.; **25**, 501.

WEBER, F., (1940, a). Vitamin C-Gehalt durch niedere Temperatur am Ergrünen verhinderter Keimlinge. Protoplasma, **34**, 314.

——, (1940, b). Frühtreiben und Vitamin C-Gehalt. Ebenda, **34**, 317.

WEISSENBÖCK, K. und M. NEUBAUER, (1940). Vitamin C-Bildung ergrünender etiolierter Pflanzen. Bot. Archiv, **41**, 93.

——, und M. WEISSENBÖCK, (1940). Vitamin C-Gehalt im Licht CO_2-frei gezogener Pflanzen. Protoplasma, **34**, 585.

ÜBER DEN ZUSAMMENHANG DER VERÄNDERUNG DES ASKORBINSÄUREGEHALTS MIT DEM KOHLENHYDRATGEHALT BEI DEN KEIMLINGEN VON *VICIA FABA*

Von

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(Mit 2 Abbildungen)

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In der Literatur können wir vielfachen Angaben über Askorbinsäureentstehung bei den Keimlingen finden (HARDEN und ZILVA '24, JOHNSON '33, EEKELEN, EMMERIE und WOLFF '34, MATSUOKA '35, STROHECKER '35, HAVAS '35, RUBIN und STRACHIZKY '36, GLICK '37, CLARK '87, REID '37, '38, MOLDTMANN '39 u. s. w.). Es wird im allgemeinen zugegeben, dass der Keimling, welcher im Dunkel gezogen ist, einen geringeren Gehalt an Askorbinsäure aufweist als der normal im Licht ergrünte (CHICK und DELF '19, HELLER '29, GIROUD '38, REID '38, SUGAWARA '39, NEUBAUER '39 u. s. w.).

Was den Askorbinsäuregehalt der Kotyledonen und seinen Zusammenhang mit dem Wachstum betrifft, so geht aus Untersuchungen von VIRTANEN und seinen Mitarbeitern ('33), RAY ('34), v. HAUSEN ('35) und NEUBAUER ('39) hervor, dass die Askorbinsäure der Kotyledonen einen notwendigen Faktor für das Wachstum darstellt. Nach VIRTANEN ('33) steht das Vitamin-C mit dem Wachstum der Pflanze in enger Beziehung. Besonders vermutet NEUBAUER ('39), dass der Anstieg im Askorbsnsäuregehalt ebenfalls eine Bereitstellung für den grösseren Bedarf der Pflanzen an Askorbinsäure zur Zeit der Bildung neuer Organe bedeutet. Nach REID ('38) besteht ein Parallelismus zwischen dem Askorbinsäuregehalt in allen Organen der Keimlinge, ob sie nun im Licht oder im Dunkel gezogen werden, und ihrem Wachstum. MOLDTMANN ('39) berichtete, dass eine erhebliche Erhöhung des Askorbinsäuregehalts bei allen Keimlingen eintrat.

In bezug auf die Askorbinsäurebildung nahm WEISSENBÖCK ('40) mit MOLDTMANN ('39) an, dass die Glukose einen wichtigen Faktor bei der Askorbinsäurebildung darstellt, und dem mehr Bedeutung zukommt als der

Photosynthese an sich und allen für sie wichtigen Faktoren in- und ausserhalb der Pflanzen wie Chlorophyllgehalt, CO_2-Gehalt der Luft, Licht u. s. w. Nach meinem vorangehenden Versuch (KAKUKAWA '43) besteht ein gewisser Parallelismus zwischen Askorbinsäure- und Kohlenhydratgehalt von grünen Blättern in ihren täglichen Schwankungen.

Wegen der Tatsache, dass Askorbinsäure auch bei vollkommenem Lichtabschluss in Keimlingen entsteht, nahm MOLDTMANN ('39) an, dass sie ihre Entstehung einzig dem dem Samen mitgegebenen Reservestoff, bzw. einer daraus gebildeten Substanz verdankt. REID ('38) beobachtete, dass bei der Erschöpfung der Reservestoffe keine weitere Askorbinsäureanhäufung in den im Dunkel gezogenen Keimlingen hervorgerufen wurde. Und zwar bekräftigte diese Annahme weiter die Tatsache, dass die Zugabe von Kohlenhydrat den Askorbinsäuregehalt in der Pflanze steigerte (RAY '33, REID '38, MOLDTMANN '39 und BUKATSCH '39, '40).

Es ist nun wünschenswert zu untersuchen, inwieweit der Askorbinsäuregehalt und der Kohlenhydratumsatz in den im Dunkel gezogenen Keimlingen kausal in Wechselbeziehung stehen. Der diesbezügliche Versuch wurde folgenderweisen ausgeführt.

MATERIAL UND METHODIK

Für diese Untersuchungen wurden die Keimlinge von *Vicia Faba* verwendet, und in Sandkulturen gezogen. Die Temperatur des Dunkelzimmers stand ohne grössere Schwankungen durchschnittlich auf 18°-20°C.

Die Bestimmung der Menge Askorbinsäure in der reduzierten und gesamten Form wurde in gleicher Weise durchgeführt, wie es bei dem vorhergehenden Versuche (KOIZUMI und KAKUKAWA '40) der Fall war. Zur Bestimmung des reduzierenden Zuckers und der Saccharose in Kotyledonen, Stengeln und Wurzeln werden 5 bis 10 gr frischen Materials genommen, und von ihnen erst die Zuckerarten mit 95%igem Alkohol extrahiert. Dabei muss darauf geachtet werden, dass zum frischen Material ein bestimmtes Volumen von 95%igem Alkohol zugegeben wird, damit die Konzentration des Alkohols nach Mischung des im Material enthaltenen Wassers noch etwa 80% beträgt. Sowohl die Extraktion des reduzierenden Zuckers und der Saccharose als auch die Hydrolyse der Saccharose und die Bestimmung der Stärke wurden nach den offiziellen Methoden, welche von A.O.A.C. (Methods of Analysis of the Association of Official Agricultural Chemists, 4th edition, 1935) empfohlen wurden, durchgeführt. Alle Zuckerarten wurden jodometrisch durch HAGEDORN-JENSENsche Methode bestimmt.

Wenn das Material aus dem Dunkelzimmer herausgebracht ist, müssen die Bestimmung der Askorbinsäure und die Extraktion der Kohlenhydrate so schnell als möglich vollendet werden, um die durch die Belichtung hervorgehende Chlorophyllentstehung, welche Assimilation zur Folge hat, zu vermeiden.

ERGEBNISSE

1. *Veränderungen des Askorbinsäure- und des Kohlenhydratgehalts in den Keimlingen.*

(*a*) *Bei Kotyledonen*

Die aus diesen Untersuchungen erhaltenen Daten sind in Tabellen 1 und 2 zusammengestellt und in Abb. 1 und 2 graphisch wiedergegeben.

Über den Wechselbezug bei *Vicia Faba* von Wachstum einerseits, Askorbinsäure- und Kohlenhydratgehalt andererseits lässt sich nach diesen Ergebnissen folgendes sagen: Im Gegensatz zur allgemeinen Behauptung, dass sich keine Askorbinsäure in ruhenden Samen befinde, wurde in diesem Versuch das Vorhandensein der Askorbinsäure, allerdings nur in vollständig reduzierter Form, bei den ruhenden Samen (Wassergehalt 17%) nachgewiesen. Der Askorbinsäuregehalt in den Kotyledonen stieg plötzlich bis zum vierten Tag nach der Aussaat, um sich danach stetig wieder zu verringern. Trotzdem konnte ein abermaliger Anstieg dadurch wiedergeschaffen werden, dass die Keimlinge vom dreizehnten Tage mit Hilfe einer Mazdalampe (200 W) im Abstande von 60 cm durch eine dicke Wasserschicht belichtet wurden. Dabei schien es mir von Bedeutung, dass sich zur Zeit der plötzlichen Steigerung des Gehalts an Askorbinsäure zuerst Hypokotyl und dann Epikotyl entwickelten. Die erhebliche Erhöhung der Askorbinsäure nach der Belichtung dürfte wahrscheinlich zu deren Umwanderung von den Stengeln zu Kotyledonen zugeschrieben werden, weil die Stengel ergrünten, während dies bei den Kotyledonen nicht der Fall war, sodass keine Assimilationsfähigkeit erwartet werden konnte.

Was nun die Veränderungen des Kohlenhydratgehalts anbelangt, so lassen uns die hier erhaltenen Ergebnisse auch folgendes erkennen: Der Stärkegehalt in den Kotyledonen sinkt stetig nach der Aussaat, was ohne weiteres dadurch begreiflich ist, dass bei der Keimung die Stärke zu anderen Kohlenhydraten, die als Energiequellen und auch zur Bildung von neuen anderen Stoffen verbraucht werden, umgesetzt wird. Der Gehalt an reduzierendem Zucker nahm allerdings nach und nach mit dem Wachstum des Keimlings zu. In bezug auf den Saccharosegehalt verhielt

TABELLE

Veränderungen des Askorbinsäure- und des Kohlenhydrat-

Tage nach Aussaat	Wasser in %	Askorbinsäure in mg/gr					
		auf Frischgewicht			auf Trockengewicht		
		Reduziert.	Oxydiert.	Gesamt.	Reduziert.	Oxydiert.	Gesamt.
0	17, 3	0, 021	——	0, 021	0, 025	—	0, 025
1	51, 0	0, 030	0, 017	0, 047	0, 061	0, 035	0, 096
2	53, 2	0, 040	0, 016	0, 056	0, 086	0, 033	0, 119
3	53, 7	0, 224	0, 032	0, 256	0, 484	0, 069	0, 553
4	58, 5	0, 249	0, 034	0, 283	0, 601	0, 062	0, 663
5	57, 4	0, 257	0, 025	0, 282	0, 602	0, 059	0, 661
6	62, 5	0, 181	0, 010	0, 191	0, 481	0, 029	0, 510
7	61, 8	0, 150	0, 026	0, 176	0, 393	0, 069	0, 462
8	66, 3	0, 134	0, 025	0, 159	0, 397	0, 065	0, 472
9	67, 9	0, 136	0, 011	0, 147	0, 425	0, 034	0, 459
10	70, 1	0, 096	0, 035	0, 131	0, 322	0, 117	0, 439
11	69, 4	0, 113	0, 027	0, 140	0, 369	0, 089	0, 458
12	68, 2	0, 122	0, 019	0, 151	0, 414	0, 052	0, 466
*13	——	——	——	——	—	—	—
14	69, 5	0, 153	0, 059	0, 212	0, 546	0, 157	0, 693
15	——	——	——	——	—	—	—
16	66, 5	0, 176	0, 033	0, 209	0, 575	0, 109	0, 684

am * Belichtung begann

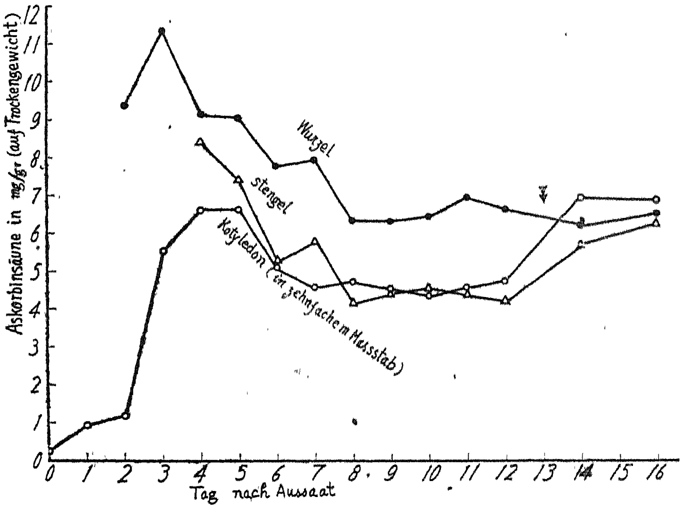

Abb. 1. Veränderungen der Askorbinsäuregehalte von Kotyledonen, Stengeln und Wurzeln der im Dunkel gezogenen Keimlinge. Bei ↓ bigann Belichtung.

1.

gehalts in Kotyledonen während der Keimung

Menge reduzierter Form / Gesamtmenge (%)	Stärke in %		Reduzierender Zucker in %		Saccharose in %	
	auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht
100, 0	41, 9	50, 6	0, 38	0, 46	2, 07	2, 43
63, 3	21, 4	43, 8	0, 40	0, 81	2, 06	4, 20
72, 8	21, 7	46, 3	0, 42	0, 90	2, 35	5, 02
87, 6	19, 5	42, 0	0, 39	0, 83	2, 06	4, 45
88, 3	20, 1	48, 4	0, 40	0, 95	2, 44	5, 87
91, 1	17, 3	46, 7	0, 45	1, 05	2, 14	5, 01
94, 4	16, 0	42, 6	0, 44	1, 18	1, 74	4, 64
85, 1	14, 2	37, 0	0, 46	1, 21	1, 92	5, 02
84, 2	14, 3	42, 5	0, 42	1, 24	1, 71	5, 08
92, 7	12, 5	39, 0	0, 44	1, 35	1, 72	5, 37
73, 3	10, 9	36, 6	0, 53	1, 77	1, 70	5, 69
80, 7	11, 3	36, 9	0, 43	1, 42	1, 73	5, 66
86, 9	9, 6	30, 2	0, 47	1, 46	1, 51	4, 76
78, 9						
84, 2						

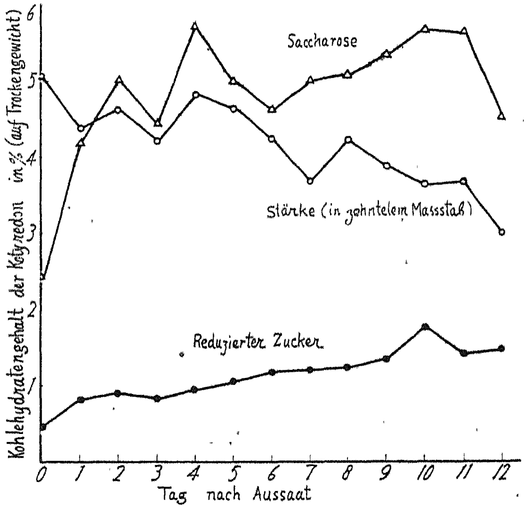

Abb. 2. Veränderungen der Kohlehydratgehalte von Kotyledonen der im Dunkel gezogenen Keimlinge.

es sich ganz anders als mit den oben genannten beiden Substanzen, und zwar erreichte er in den ersten Stadien der Keimlingsentwicklung einen Maximumwert, um dann beständig zu sinken. Vergleichen wir diese Tatsache mit dem Askorbinsäuregehalt der Kotyledonen, so ist es sehr wahrscheinlich, dass ein gewisser Parallelismus zwischen dem Askorbinsäure- und Saccharosegehalt besteht. Schliesslich muss betont werden, dass sich am An-

TABELLE

Veränderungen des Askorbinsäure- und des Kohlenhydrat-

Tage nach Aussaat	Länge der Epikotylen in cm	Wasser in %	Askorbinsäure in mg/gr				
			auf Frischgewicht			auf Trockengewicht	
			Reduziert.	Oxydiert.	Gesamt.	Reduziert.	Oxydiert.
4	0,7	90,4	0,697	0,117	0,814	7,268	1,220
5	3,9		0,580	0,131	0,711	6,048	1,326
6	7,6		0,462	0,045	0,507	4,818	0,469
7	11,1		0,417	0,088	0,505	4,788	1,010
8	14,7	91,3	0,322	0,042	0,364	3,697	0,582
9	15,5		0,333	0,051	0,384	3,823	0,586
10	16,6	91,8	0,322	0,050	0,372	3,807	0,746
11	17,7		0,325	0,042	0,367	3,978	0,514
12	19,3		0,303	0,043	0,346	3,709	0,526
*13	—		—	—	—	—	—
14	—		0,437	0,036	0,473	5,332	0,444
15	—		—	—	—	—	—
16	—	91,8	0,442	0,070	0,512	5,412	0,849

TABELLE

Veränderungen des Askorbinsäure- und des Kohlenhydrat-

Tage nach Aussaat	Länge der Hypokotylen in cm	Wasser in %	Askorbinsäure in mg/gr				
			auf Frischgewicht			auf Trockengewicht	
			Reduziert.	Oxydiert.	Gesamt.	Reduziert.	Oxydiert.
2	1,2		0,343	0,310	0,653	4,907	4,433
3	2,7	93,0	0,654	0,138	0,792	9,356	1,974
4	3,9		0,502	0,138	0,640	7,182	1,974
5	4,3		0,477	0,155	0,632	6,824	2,217
6	6,1		0,462	0,080	0,542	6,609	1,145
7	7,1		0,403	0,125	0,528	6,042	1,874
8	8,0	93,3	0,367	0,057	0,424	5,502	0,855
9	7,8		0,355	0,067	0,422	5,322	1,005
10	8,2	93,3	0,346	0,084	0,430	5,164	1,254
11	9,8		0,362	0,106	0,468	5,403	1,582
12	9,3		0,352	0,096	0,448	5,254	1,433
*13	—		—	—	—	—	—
14	—		0,335	0,088	0,423	4,931	1,293
15	—		—	—	—	—	—
16	—	93,2	0,331	0,102	0,433	4,943	1,518

am * Belichtung begann

fang der Keimung Dehydroaskorbinsäure verhältnismässig reichlich vorfindet.

(*b*) *Bei Keimstengeln und -wurzeln*

Die Bestimmung der Askorbinsäure wurde bei den Stengeln (Epikotylen) in dem Entwicklungsstadium vom vierten Tag nach der Aussaat an und bei den Wurzeln (Hypokotylen) vom dritten Tag an ausgeführt. Aus den Ergebnissen, die in Tabellen 2 und 3 zusammengestellt sind, geht hervor, dass

2.

gehalts in Epikotylen (Stengeln) während der Keimung

	Menge reduzierter Form / Gesamtmenge (%)	Stärke in %		Reduzierender Zucker in %		Saccharose in %	
Gesamt.		auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht
8,488	85,6						
7,414	81,6						
5,287	91,1						
5,798	82,6						
4,179	88,5						
4,409	86,7	48,0	55,1	2,36	27,03	0,08	0,95
4,553	83,6						
4,492	88,6						
4,235	87,6						
		50,3	61,4	1,60	19,55	0,22	2,66
5,774	92,4						
6,261	86,4						

3.

gehalts in Hypokotylen (Wurzeln) während der Keimung

	Menge reduzierter Form / Gesamtmenge (%)	Stärke in %		Reduzierender Zucker in %		Saccharose in %	
Gesamt.		auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht
9,342	52,5						
11,330	82,6						
9,156	78,4						
9,041	75,5						
7,754	85,2						
7,916	76,3						
6,357	86,6						
6,327	84,1	53,3	79,9	0,93	13,94	0,21	3,19
6,418	80,5						
6,985	77,4						
6,687	78,6						
		56,6	83,4	0,65	9,57	0,88	12,90
6,224	79,2						
6,461	76,5						

der Askorbinsäuregehalt sowohl bei Stengeln als auch bei Wurzeln schon am vierten oder fünften Tag den Maximumwert erreicht, um dann schnell abzunehmen. Der Verlust an Askorbinsäure in Stengeln und in Wurzeln verhielt sich parallel zu dem in den Kotyledonen (vergl. Abb. 1).

Die ausserordentlich hohe Anhäufung der Askorbinsäure in Epikotyl und auch in Hypokotyl im ersten Stadium ihrer Entwicklung gerade zur Zeit des Anstiegs des Askorbinsäuregehaltes in den Kotyledonen führt uns zur Vermutung, dass die Askorbinsäure eine gewisse Bedeutung für die Bildung dieser Organe besitzt. NEUBAUER ('39) kam ebenfalls zu derselben Vermutung.

Der Stärke- und der Saccharosegehalt in Stengeln und auch in Wurzeln nahm, im Gegensatz zur Verminderung in den Kotyledonen, mit der Zeit zu, während der Gehalt an reduzierendem Zucker in beiden abnahm. Anderseits stieg der Askorbinsäuregehalt besonders in den Stengeln bei Belichtung der Keimlinge, ganz wie in den vorigen Versuchen an den Kotyledonen, mit dem gleichzeitig erfolgten Ergrünen auf.

2. *Die Verteilung der Askorbinsäure in Keimlingen, besonders in Stengeln und Wurzeln.*

Weiter wurde die Verteilung der Askorbinsäure in Stengeln und Wurzeln untersucht. Die erhaltenen Ergebnisse sind in Tabelle 4 wiedergegeben.

TABELLE 4.

Verteilung der Askorbinsäure in Keimlingen, besonders in Stengeln und in Wurzeln

Untersuchte Teile		Tage nach Aussaat	Wasser in %	Askorbinsäure in mg/gr						Menge reduzierter Form / Gesamtmenge (%)
				auf Frischgewicht			auf Trockengewicht			
				Red.	Oxyd.	Gesamt.	Red.	Oxyd.	Gesamt.	
Stengel	Oberer Teil	7	91, 3	0, 473	0, 065	0, 538	5, 430	0, 747	6, 177	87, 9
		9	91, 3	0, 485	0, 120	0, 605	5, 568	1, 478	6, 946	80, 2
		13	91, 8	0, 384	0, 063	0, 447	4, 700	0, 771	5, 471	85, 9
		17	91, 8	0, 431	0, 098	0, 529	5, 260	1, 202	6, 462	81, 4
	Unterer Teil	3	91, 3	0, 289	0, 057	0, 346	3, 320	0, 652	3, 972	83, 6
		9	91, 3	0, 270	0, 077	0, 347	3, 000	0, 984	3, 984	75, 3
		13	91, 8	0, 259	0, 034	0, 293	3, 170	0, 416	3, 586	88, 5
		17	91, 8	0, 305	0, 049	0, 354	3, 721	0, 597	4, 318	86, 2
Wurzel	Basis	7	93, 3	0, 293	0, 159	0, 452	4, 393	2, 384	6, 777	64, 8
		9	93, 3	0, 318	0, 097	0, 415	4, 768	1, 454	6, 222	76, 6
		13	93, 3	0, 270	0, 104	0, 374	4, 030	1, 552	5, 582	72, 2
		17	93, 2	0, 354	0, 115	0, 469	5, 209	1, 691	6, 900	75, 5
	Spitze	7	93, 3	0, 382	0, 042	0, 424	5, 727	0, 630	6, 357	90, 1
		9	93, 3	0, 420	0, 287	0, 707	6, 297	4, 303	10, 600	59, 4
		13	93, 3	0, 373	0, 077	0, 450	5, 567	1, 149	6, 716	82, 9
		17	93, 2	0, 498	0, 082	0, 580	7, 331	1, 211	8, 542	85, 8

Es geht aus diesen Ergebnissen hervor, dass sich sowohl bei dem oberen und unteren Teil des Stengels als auch bei der Wurzelspitze und -basis übereinstimmend der höhere Askorbinsäuregehalt gerade in den Regionen der höheren Wachstumsaktivität findet. Diese Tatsache wurde auch schon von GIROUD ('38), REID ('37), MOLDTMANN ('39) und NEUBAUER ('40) beobachtet. REID und NEUBAUER schrieben die an den Wurzelspitzen gefundenen höheren Askorbinsäurewerte der Zellaktivität zu, nicht wie GIROUD, der sie dem Ergrünen der Wurzeln zuschrieb.

3. *Einfluss der Entfernung der Kotyledonen auf den Askorbinsäuregehalt des Stengels und der Wurzel*

So entsteht nun eine Frage, inwieweit der Askorbinsäuregehalt des Stengels und der Wurzel durch die Entfernung der Kotyledonen beeinflusst wird. Wie zu erwarten ist, kommen die Keimlinge nach Entfernung der Kotyledonen durch Nichtlieferung der Reservestoffe mit der Zeit etwas zum Einschrumpfen. An solchen Keimlingen wurde zum Vergleich mit den normal entwickelten der Gehalt an Askorbinsäure untersucht. Die erhaltenen Ergebnisse sind in Tabelle 5 zusammengestellt.

TABELLE 5.

Askorbinsäuregehalt des Stengels und der Wurzel nach Entfernung der Kotyledonen

	Tage nach Aus-aat	Tage nach Behandlung		Wasser in %	Askorbinsäure in mg/gr						Menge reduzierter Form / Gesamtmenge (%)
					auf Frischgewicht			auf Trockengewicht			
					Red.	Oxyd.	Gesamt.	Red.	Oxyd.	Gesamt.	
Stengel	12	2	Behandelt	91, 0	0, 394	0, 052	0, 446	4, 365	0, 571	4, 936	88, 3
			Kontrolle		0, 440	0, 042	0, 482	4, 856	0, 480	5, 336	91, 3
	16	6	Behandelt		0, 365	0, 036	0, 401	4, 041	0, 394	4, 335	91, 0
			Kontrolle		0, 384	0, 022	0, 406	4, 252	0, 244	4, 496	94, 6
Wurzel	12	2	Behandelt	91, 5	0, 330	0, 086	0, 416	3, 875	1, 013	4, 888	79, 3
			Kontrolle		0, 384	0, 115	0, 499	4, 506	1, 354	5, 860	77, 0
	16	6	Behandelt		0, 230	0, 080	0, 310	2, 703	0, 910	3, 643	74, 2
			Kontrolle		0, 305	0, 118	0, 423	3, 579	1, 387	4, 966	72, 1

Aus Tabelle 5 ist ersichtlich, dass der Askorbinsäuregehalt sowohl des Stengels als auch der Wurzel der behandelten Pflanzen im Vergleich mit dem der intakt gebliebenen geringer wird. Beachtenswert ist es aber, dass der Unterschied im Askorbinsäuregehalt zwischen den ihrer Kotyledonen beraubten und der intakt gebliebenen Pflanzen eben bei den Wurzeln grösser als bei den Stengeln ist.

4. *Askorbinsäure- und Kohlenhydratgehalt in den Kotyledonen nach Entfernung des Stengels oder der Wurzel*

Wir kommen nun zur Betrachtung, inwieweit der Gehalt an Askorbinsäure und an Kohlenhydraten in den Kotyledonen nach Entfernung des Stengels oder der Wurzel beeinträchtigt wird. Der diesbezügliche Versuch wurde wie folgt ausgeführt. Am siebenten Tag nach der Aussaat wurde der Stengel oder die Wurzel der Keimlinge abgeschnitten. Am zweiten und achten Tag danach wurden die Bestimmungen der Askorbinsäure und der Kohlenhydrate durchgeführt. Die Ergebnisse sind in Tabelle 6 zusammengestellt.

Der Unterschied im Askorbinsäuregehalt zwischen den operierten und den intakt gebliebenen Pflanzen ist am zweiten Tag noch nicht nennenswert, erst am achten Tag ist er beträchtlicher ausgefallen, indem der Ge-

TABELLE

Askorbinsäure- und Kohlenhydratgehalt der Keim-

		Tage nach Aussaat	Tage nach Behandlung		Wasser in %	Askorbinsäure in			
						auf Frischgewicht			auf
						Red.	Oxyd.	Gesamt.	Red.
Von Wurzel beraubter Keimling	Kotyledon	9	2	Behandelt	66, 3	0, 228	0, 028	0, 256	0, 677
				Kontrolle		0, 188	0, 039	0, 227	0, 558
		15	8	Behandelt	70, 4	0, 157	0, 041	0, 198	0, 530
				Kontrolle		0, 110	0, 009	0, 119	0, 337
	Stengel	9	2	Behandelt	91, 3	0, 476	0, 068	0, 544	5, 464
				Kontrolle		0, 519	0, 046	0, 565	5, 961
		15	8	Behandelt	91, 8	0, 349	0, 039	0, 388	4, 261
				Kontrolle		0, 220	0, 081	0, 301	2, 686
Von Stengel beraubter Keimling	Kotyledon	9	2	Behandelt	66, 3	0, 186	0, 037	0, 223	0, 550
				Kontrolle		0, 188	0, 039	0, 227	0, 558
		15	8	Behandelt	70, 4	0, 170	0, 051	0, 221	0, 574
				Kontrolle		0, 110	0, 009	0, 119	0, 337
	Wurzel	9	2	Behandelt	93, 3	0, 643	0, 131	0, 774	9, 640
				Kontrolle		0, 671	0, 165	0, 836	10, 052
		15	8	Behandelt	93, 2	0, 252	0, 138	0, 390	3, 711
				Kontrolle		0, 294	0, 077	0, 371	4, 330

halt an Askorbinsäure bei operierten Kotyledonen grösser war als der, der an den Kontrollen aufgewiesen wurde. Abgesehen von einigen Ausnahmen war der Kohlenhydratgehalt in Kotyledonen von operierten Pflanzen im allgemeinen ebenfalls grösser als der von normalen. Es muss hierbei darauf hingewiesen werden, dass am achten Tag nach der Behandlung einige Ersatzsprosse oder Ersatzwurzeln ins Wachsen kamen. Dies steht sehr wahrscheinlich im Zusammenhang mit der Tatsache, dass der Askorbinsäuregehalt in den Kotyledonen der Pflanzen nach Entfernung der normalen Sprosse unmittelbar vor der Ausbildung neuer Sprosse auf ein zweites Maximum ansteigt.

Wenn man die Zahlenwerte der Tabellen 1 und 6 vergleicht, so wird es ersichtlich, dass sich die Annahme NEUBAUERS für die Kotyledonen, deren Epikotyl abgeschnitten wurde, auch in dem Falle bestätigt findet, wo den Kotyledonen die Wurzel entfernt wurde, weil sich in unseren Versuchen der Askorbinsäuregehalt der von Stengel oder Wurzel getrennten Keimlinge gerade am achten Tag gleichwohl grösser als der der Kontrolle auf-

6.

linge nach Entfernung der Stengeln oder der Wurzeln

mg/gr Trockengewicht		Menge reduzierter Form / Gesamt-Menge (%)	Stärke in %		Reduzierender Zucker in %		Saccharose in %	
Oxyd.	Gesamt.		auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht	auf Frischgewicht	auf Trockengewicht
0, 083	0, 760	89, 1	17, 6	52, 3	0, 40	1, 18	1, 82	5, 39
0, 114	0, 672	83, 1	13, 5	40, 2	0, 64	1, 88	3, 17	9, 35
0, 139	0, 669	79, 3	9, 0	30, 1	0, 53	1, 79	2, 12	7, 16
0, 065	0, 402	83, 9	11, 8	39, 6	0, 43	1, 43	1, 56	5, 25
0, 782	6, 246	87, 5						
0, 526	6, 487	91, 9						
0, 576	4, 737	89, 9						
0, 983	3, 669	73, 2						
0, 112	0, 662	83, 2	16, 5	48, 7	0, 51	1, 49	3, 62	10, 68
0, 114	0, 672	83, 1	13, 6	40, 2	0, 64	1, 88	3, 17	9, 35
0, 172	0, 746	77, 0	14, 1	47, 4	0, 47	1, 59	2, 68	9, 02
0, 065	0, 402	87, 5	11, 8	39, 6	0, 43	1, 43	1, 56	5, 25
1, 964	11, 604	83, 1	—	—	—	—	—	—
2, 476	12, 528	80, 2						
2, 028	5, 739	64, 7	—	—	—	—	—	—
1, 128	5, 458	79, 3						

wies. Diese Tatsache kann uns zur Annahme führen, dass der grössere Askorbinsäuregehalt im Stengel oder in der Wurzel behandelter Pflanze auf ihre Anhäufung gerade in den Kotyledonen zurückgeführt werden darf, indem erst danach einiger Anteil derselben in die betreffenden Organe verschoben wird.

Trotz dieser bei uns vorliegenden Ergebnisse bleibt noch unerklärt, ob der Stengel bzw. die Wurzel der im Dunkel gezogenen Pflanzen die Fähigkeit der Askorbinsäuresynthese besitzt, oder die Askorbinsäure, die diese Organe enthalten, nur von den Kotyledonen herrührt.

BESPRECHUNG DER ERGEBNISSEN

Moldtmann ('39) konnte keine Askorbinsäure in ruhenden Samen nachweisen. Giroud ('38) allerdings erwähnte, dass sich in den Samen von Tomate und Paprika eine beträchtliche Menge vorfindet. Nach meinem Versuch an *Vicia Faba* findet sie sich ebenfalls mässig vor, und zwar in vollständig reduzierter Form. Dabei betrug der Wassergehalt der Samen ungefähr 17%.

Was den Askorbinsäuregehalt der Keimlinge anbelangt, so sind bisher zahlreiche Untersuchungen in der Literatur mitgeteilt worden. Es wurde ja schon angenommen, dass die Askorbinsäure in enger Beziehung zu Wachstum und Keimung steht (Euler und Klussmann '33, Ray '34, v. Hausen '35, Reid '38, Neubauer '39 u. s. w.) Aus meinem Versuch ist hervorgegangen, dass sich zur Zeit des plötzlichen Anstiegs im Askorbinsäuregehalt der Kotyledonen in den ersten Stadien der Keimlingsentwicklung zuerst Hypokotyl und dann Epikotyl entwickelt. Ähnliche Tatsachen wurden schon von Reid ('38), Moldtmann ('39) und Neubauer ('39) beobachtet. Nach Neubauers Bestimmungen des Askorbinsäuregehaltes der Kotyledonen in verschiedenen Stadien der Keimlingsentwicklung wird ein Maximum im Askorbinsäuregehalt unmittelbar vor der Nebenwurzelbildung erreicht. In meinem Versuch wurde ebenfalls eine ganz dementsprechende Tatsache gefunden. Aus diesen Befunden geht hervor, dass die Askorbinsäure der Kotyledonen einen notwendigen Faktor für die Keimung darstellt. Das geht auch daraus überzeugend hervor, dass die Anhäufung der Askorbinsäure gerade zur Zeit der Ersatzsprossen-bezw. der Ersatzwurzelentwicklung nach der Entfernung des Stengels oder der Wurzel, gefunden wurde.

Der Gehalt an Stärke nimmt mit der Zeit ab und der an reduzierendem Zucker verhält sich gerade umgekehrt. Bei der Saccharose ist die Sache ganz anders als in den beiden obengenannten Fällen, indem ihr Gehalt gerade im ersten Stadium der Entwicklung einen Maximumwert erreicht, um dann etwas zu sinken. Es scheint mir wahrscheinlich, dass ein gewisser Parallelismus zwischen dem Askorbinsäure- und dem Saccharosegehalt in den Kotyledonen besteht. Diese Tatsache steht wahrscheinlich mit den von RUBIN und seinen Mitarbeitern ('39) und TADOKORO und NISIDA ('40) ausgeführten Beobachtungen im Einklang. RUBIN und seine Mitarbeiter berichteten, dass, wenn die Saccharoselösung in den Weizenkeim drang, sein Askorbinsäuregehalt zunahm. Als eine Ursache, weshalb bei niedriger Temperatur die Saccharosebildung der jungen Pflanzen von Zuckerrüben und Zuckerrohr zunimmt, führen TADOKORO und NISIDA die Tatsache an, dass bei der genannten Bedingung wenig Saccharose in Askorbinsäure übergehen kann. Andererseits führt die Zunahme des Saccharosegehaltes, die durch das fluoreszierende Reizmittel hervorgerufen wird, gleichzeitig zur Zunahme des Askorbinsäuregehaltes. Im Zusammenhang mit diesen Befunden interessiert mich der Versuch von JAMES ('40), der dem Kohlenhydratstoffwechsel bei Gerstenkeimlingen gewidmet ist. Er gelangte zum Schluss, dass sich bei der Keimung die Veränderung der Kohlenhydrate deutlicher und schneller im Saccharosegehalt als in anderen Zuckerarten spiegelte und dieser Zucker für die Atmung und dem Aufbau des Zellwandmaterials von grösster Bedeutung ist. Auch die Befunde BUKATSCHS ('39 und '40) erregen in dieser Beziehung mein Interesse, dass nämlich durch Zufuhr von Askorbinsäure neben der Förderung der Assimilation auch die Atmungssteigerung für Wasserpflanzen festgestellt werden konnte.

GAL ('38) untersuchte die Einwirkung der organischen Säure auf die Keimung, das Wachstum und den Askorbinsäuregehalt der Gernstenkeimlinge und kam zum Ergebnis, dass die verschiedene Wirkung der einzelnen Säure und ihr Zusammenhang mit der Zunahme des Gehalts an Askorbinsäure der Keimlinge eine komplizierte Beziehung zwischen diesen und einem die Askorbinsäure beherrschenden System erkennen liessen.

Nun kommt in Frage, ob Epikotyl und Hypokotyl der im Dunkel gezogenen Keimpflanzen die Askorbinsäure aus den Zucker, der von den Reservestoffbehältern, den Kotyledonen, her geliefert wird, synthetisch zu bilden vermögen. CLARK ('37) meinte, dass in der Coleoptilspitze die Synthese der Askorbinsäure vor sich ging. Gegen die Basis hin nimmt der Gehalt an Askorbinsäure — nach seiner Vermutung zwar unter der Wirkung eines Enzyms — ab. Auch in meinen Versuchen liegen ähnliche Verhältnisse vor, indem der Askorbinsäuregehalt sowohl in Epikotylen als auch in Hypokotylen gerade in den Regionen mit grösster Zellaktivität sich vermehrt. Dies wurde ebenfalls von anderen Autoren beobachtet (GIROUD '38, REID '37, MOLDTMANN '39, NEUBAUER '40 u. s. w.).

Die Ergebnisse, dass die ihrer Kotyledonen beraubte Keimpflanze einen geringeren Askorbinsäuregehalt sowohl in Epikotyl als auch in Hypokotyl im Vergleich zur normal entwickelten wieder spiegelt, lassen uns die Frage aufwerfen, ob dieser geringere Gehalt an Askorbinsäure entweder nur dem Ausfall der Askorbinsäureabwanderung aus den Kotyledonen oder auch der Unmöglichkeit der Askorbinsäuresynthese aus den Reservestoffen zuzuschreiben ist.

Der Befund aus dem Versuche mit Keimpflanzen, deren Epikotyl oder Hypokotyl beraubt worden sind, scheint mir von Bedeutung. Darin ist klar gezeigt, dass dabei der Gehalt sowohl an Askorbinsäure (man vgl. NEUBAUER '39) als auch an Kohlenhydraten in den Kotyledonen, und betreffs der Askorbinsäure auch im Epikotyl oder im Hypokotyl, höher ausfällt als der bei der Kontrolle. In ähnlicher Untersuchung gab WEISSENBÖCK ('40) eine Erklärung für die Tatsache, dass die ihrer Kotyledonen beraubten Keimlinge sich in bezug auf ihren Askorbinsäuregehalt und ihre Stärkebildung genau so verhalten wie Keimlinge mit reichlichem Samen-Reservestoff: Vielleicht verbrauchen sie infolge ihres geringen Wachstum und der zurückbleibeden Entwicklung keine oder nur wenig Askorbinsäure. Um diese Frage zu beantworten, muss man noch weitere Untersuchungen anstellen.

Durch die Belichtung der Keimlinge wurde ein erheblicher Anstieg im Askorbinsäuregehalt hervorgerufen. Diese Abhängigkeit des Askorbinsäuregehaltes von der Photosynthese geht auch aus den Mitteilungen von mehreren Autoren (MOLDTMANN '39, SUGAWARA '39, WEBER '40, a. b., WEISSENBÖCK '40 u. s. w.) hervor. WEBER ('40 a.) beobachtete, dass die Erhöhung des Askorbinsäuregehaltes der bei niedriger Temperatur dem Licht ausgesetzten Keimlinge parallel mit der Steigerung ihres Karotinoidgehaltes ging. Er nahm dabei an, dass das Licht auch bei niedriger Temperatur die Karotinoid-Bildung fördert. Es ist nun von anderen Autoren erwiesen worden, dass ein ähnlicher Zusammenhang wie zwischen Askorbinsäure und Chlorophyll auch zwischen Askorbinsäure und Karotin besteht (GIROUD '38, DISCHENDORFER '37, NEUBAUER '39, MOLDTMANN '39 u.s.w.). MOTHES und seine Mitarbeiter ('39) untersuchten die Bedeutung der Karotinoide für die Lichtausnutzung bei der Photosynthese. VIRTANEN und seine Mitarbeiter ('33) berichteten, dass das Karotin als ein wesentlicher Wachstumsfaktor der Pflanzen betrachtet werden kann und die Schwankungen im Gehalt an Askorbinsäure in vieler Hinsicht denjenigen des Karotin-gehalts ähnlich waren. Bei alledem bleibt noch zu untersuchen, inwieweit die Askorbinsäure mit der Karotinoidbildung bzw. dem Kohlenhydratstoffwechsel bei der Keimung in inniger Beziehung steht.

ZUSAMMENFASSUNG

1. In ruhenden Samen wird die Askorbinsäure nur in vollständig reduzierter Form nachgewiesen, während die Dehydroaskorbinsäure am Anfang der Keimung zunimmt, um später abzunehmen.

2. Im Dunkel steigt der Askorbinsäuregehalt der Kotyledonen plötzlich bis zum vierten Tag nach der Aussaat, verringert sich aber stetig wieder; die Belichtung der zu dieser Abnahme geneigten Keimlinge führt einen abermaligen Anstieg herbei.

3. Bei Kotyledonen, die im Dunkel gezogen wurden, weist der Stärkegehalt fortwährendes Absinken auf und beim reduzierenden Zucker ist gerade umgekehrtes gültig. Der Saccharosegehalt verhält sich ganz anders als diese beiden Fälle, und zwar erreichte er gleich im ersten Entwicklungsstadium nach der Aussaat einen Maximumwert, um dann etwas zu sinken. Es ist sehr wahrscheinlich, dass ein Parallelismus zwischen dem Askorbinsäure- und dem Saccharosegehalt besteht.

4. Der Askorbinsäuregehalt der Stengel (Epikotylen), der vom vierten Tag nach der Aussaat an bestimmt wurde, wies anfangs seinen Maximumwert auf, um danach schnell abzunehmen. Bei den Wurzeln (Hypokotylen) wies der Askorbinsäuregehalt, dessen Bestimmung vom dritten Tag nach der Aussaat an ausgeführt wurde, nach Erreichung des Maximumwertes auch einen schnellen Verlust auf. Bemerkenswert ist die Tatsache, dass der Gehalt an Askorbinsäure sowohl bei Hypokotylen als auch bei Epikotylen ausserordentlich höher war als bei den Kotyledonen.

5. Der Stärke- und der Saccharosegehalt in Stengeln und in Wurzeln nimmt, im Gegensatz zu dem der Kotyledonen, mit der Zeit zu, aber der Gehalt an reduzierendem Zucker nimmt in beiden ab.

6. Der deutliche Unterschied im Askorbinsäuregehalt zwischen den oberen und unteren Teilen des Stengels bzw. zwischen der Wurzelspitze und -basis deutet darauf hin, dass die Askorbinsäure den Regionen mit höherer Wachstumsaktivität reichlicher zur Verfügung gestellt wird.

7. Der Askorbinsäuregehalt des Stengels oder der Wurzel von Pflanzen, die ihrer Kotyledonen beraubt sind, ist geringer als der der Kontrolle.

8. Der Unterschied zwischen den von Stengel oder Wurzel beraubten Kotyledonen und der Kontrolle in ihrem Askorbinsäure- und Kohlenhydrat-

gehalt wird, abgesehen von einigen Ausnahmen, mit der Zeit deutlicher.

An dieser Stelle sei es mir gestattet, Herrn Prof. Dr. Y. Yamaguti für alle wertvollen Ratschläge und für liebenswürdige Revision dieser Arbeit meinen tiefgefühlten Dank auszusprechen.

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LITERATURVERZEICHNIS

Bukatsch, F., (1939). Über die Rolle der Askorbinsäure in den Chloroplasten. Planta, **30**, 118.

——, (1940). ——. II. Mitt. Ebenda, **31**, 209.

Chick, H. und E. M. Delf, (1919). The antiscorbutic value of dry and germinated seeds. Biochem. J., **13**, 199.

Clark, W. G., (1937). Ascorbic acid in the Avena coleoptiles. Bot. Gaz., **99**, 116.

Dischendorfer, O., (1937). Über den histochemischen Nachweis von Vitamin-C (l-Ascorbinsäure) in Pflanzen. Protoplasma, **28**. 516.

Eekelen, M. van, A. Emmerie and L. K. Wolff, (1934). Determination of Vitamin C in germinated seeds. Acta brevia Neerland, **4**, 3. Zit. nach Giroud (1938).

Euler, H. v. und E. Klussmann, (1933). Zur Biochemie der Carotinoide und des Vitamin C (Askorbinsäure). Z. f. physiol. Chem., **219**, 215.

Gal, E., (1938). Effect of organic acid on germination, growth and ascorbic acid content of wheat seedlings. Nature, **142**, 1119.

Giroud, A., (1933). L'acid ascorbique dans la cellule et le tissus. Protoplasma Monographien, **16**, Berlin.

Glick, D., (1937). The quantitative distribution of ascorbic acid in the developing barley embryo. C. r. Trav. Lab. Carlsberg, **21**, 203. Zit. nach Moldtmann (1939).

Harden, A. and S. S. Zilva, (1924). The investigation of barley, malt, and beer for vitamin B and C. Biochem. J., **18**, 1129.

Hausen, S. V., (1935). Effect of vitamin C in the growth of plants. Saumen Kem., **8**, B, 50. Zit. nach Neubauer (1939).

Havas, L., (1935). Ascorbic acid (vitamin C) and the germination and growth of seedlings. Nature, **136**, 435.

Heller, V. G., (1928). Light effect on vitamin synthesis. J. Biol. Chem., **76**, 499.

James, A. L., (1940). The carbohydrate metabolism of germinating barley. New Phytologist, **39**, 133.

James, O. W. and A. L. James, (1940). The respiration of barley germinating in the dark. Ebenda, **39**, 145.

Johnson, S. W., (1933). The indophenol reducing capacity and the vitamin C content of extracts of young germinated peas. Biochem. J., **27**, 1942.

Kakukawa, T., (1943). Schwankungen des Gehalts an Askorbinsäure und Kohlenhydraten in Pflanzenblättern während der verschiedenen Tageszeiten. Sci. Rep. Tôhoku Imp. Univ., Biol., **17**, 301.

KOIZUMI, T. and T. KAKUKAWA, (1940). On the vitamin-C (ascorbic acid) content of harbaceous plants and marine algae, considering factors influencing it. Ebenda, **15**, 105.

MATSUOKA, T., (1935). Studies on vitamin C. VII. On the change of content of vitamin C in barley. Mem. Coll. Agric. Kyoto Imp. Univ., **35**, 93.

MIRIMANOFF, A., (1938). Acide ascorbique et pigments caroténoides. Signification de la réaction de MOLISCH et essai de localisation de l'acide ascorbique. C. r. Acad. Sci. Paris, **206**, 1038.

MOLDTMANN, H., (1939). Untersuchungen über den Askorbinsäuregehalt der Pflanzen in seiner Abhängigkeit von inneren und äusseren Faktoren. Planta, **30**, 297.

MOTHES, K., I. BAATZ und H. SAGROMSKY, (1939). Die Bedeutung der Carotinoide für die Lichtausnützung bei der Photosythese. Planta, **30**, 289.

NEUBAUER, M., (1939). Das Vitamin C in der Pflanze. Protoplasma, **33**, 345.

RAY, S. N., (1934). On the nature of precursor of the vitamin C in the vegetable kingdom. I. Vitamin C in the growing pear seedling. Biochem. J., **28**, 996.

REID, M. E., (1937). Localization of ascorbic acid in the cowpea plant at different periods of development. Amer. J. Bot., **24**, 445.

——, (1938). The effect of light on the accumulation of ascorbic acid in young cowpea plants. Ebenda, **25**, 701.

RUBIN, B. A. und K. STRACHIZKY, (1936). On the biological role of vitamin C in the plant. Biokhimiya, **1**, 343. Chem. Abst., **31**, 7466, 1937.

——, B. A. ARTSIKHOVSKAYA, N. S. SPIRIDONOVA and O. T. LUTIKOVA, (1939). Sources of vitamin C formation in the living plant cell. Biokhimiya, **4**, 260. Chem. Abst., **34**, 1711 (1940).

STROHECKER, R., (1935). Über die Bildung, Entstehung, und das örtliche Vorkommen von Vitamin C in pflanzlichen Geweben. Z. Untersuch. Lebensm., **70**, 76.

SUGAWARA, T., (1939). Studies on the formation of ascorbic acid (vitamin C) in plants. I. The influence of light on the ascorbic acid contents in various etiolated seedlings. Jap. J. Bot., **10**, 141.

TADOKORO, T. and M. NISIDA, (1940). Stimulant for sucrose formation in plants. VI. (Japanisch). J. Agr. Chem. Soc. Japan, **16**, 501.

VIRTANEN, A. J., S. v. HAUSEN und S. SAASTEMOINEN, (1933). Untersuchungen über die Vitaminbildung in Pflanzen. Biochem. Z., **267**, 179.

WEBER, F., (1939). Vitamin C-Gehalt ergrünter Rhizom-Knollen von Stachys. Protoplasma, **34**, 153.

——, (1940, a). Vitamin C-Gehalt durch niedere Temperatur am Ergrünen verhinderter Keimlinge. Ebenda, **34**, 314.

——, (1940, b). Frühtreiben und Vitamin C-Gehalt. Ebenda, **34**, 317.

WEISSENBÖCK, K. und M. NEUBAUER, (1940). Vitamin C-Bildung ergrünender etiolierter Pflanzen. Bot. Archiv, **41**, 93.

—— und M. WEISSENBÖCK, (1940). Vitamin C-Gehalt im Licht CO_2-frei gezogener Pflanzen. Protoplasma, **34**, 585.

THE ECOLOGICAL OBSERVATION ON *SPIRORBIS*, ESPECIALLY ON THE POST-LARVAL DEVELOPMENT OF *SPIRORBIS ARGUTUS* BUSH

BY

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(With 14 Text-figures)

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INTRODUCTION

Some species that belong to the genus *Spirorbis*, rather common in the neighbourhood of the Asamushi Marine Biological Station, are met with in such places as the shallow tide-pool, etc. They are found attached to the algae, especially to *Sargassum*. It is often noticed that many of *Spirorbis* enter into the aquarium together with the seawater induced, and thus they attach to the glass wall of the vessel.

According to Mr. KEIZO TAKAHASHI, one of the authorities working on the Polychaetous Annelid, it is said that the *Spirorbis* of Japan is not yet fully studied from the ecological and systematic point of view. A very common species found on *Sargassum* was first reported from Japan as a new species under the name of *Spirorbis argutus* by CATHALIN BUSH in 1904. But no further reports on the same species have been appeared till the present time.

On the other hand, it is generally observed that if some quantity of seawater taken from the seashore is put in a glass vessel and left it quietly for several days, then a number of white spots will appear on the glass wall and they are identified to be either *Spirorbis* or *Serpula*.

Some observations dealt with in the present paper had been carried out by the present author, using such materials mentioned just above, during the period extending from the summer of 1938 to July of 1939 at the Asamushi Marine Biological Station.

Before going further, the writer wishes to express his sincere thanks to Prof. Dr. SANJI HOZAWA for the kind guidance given to the writer during the course of the present study, and his gratitude is also paid to Mr. KEIZO TRKAHASHI of Tokyo Bunrika University for the kindness given to the writer in identifying the species.

I. THE DESCRIPTION ON THE SPECIES OF *SPIRORBIS*, FOUND IN THE NEIGHBOURHOOD OF ASAMUSHI

There may be found several species of *Spirorbis* living in the neighbourhood of the Asamushi Marine Biological Station, among which about 4 species are rather common, and their morphological characteristics are shown in the following and in Fig. 1.

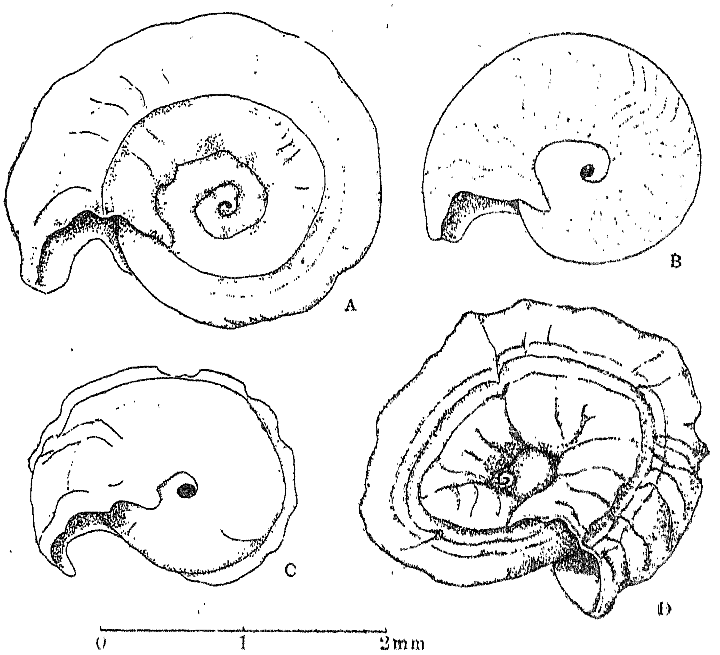

Fig. 1. Morphorogical characteristics shown by the four species *Spirorbis* common in the neighbourhood of Asamushi.
A, *Spirorbis argutus* BUSH; B, *Spirorbis* sp. 2; C, *Spirorbis* sp. 1; D, *Spirorbis pagenstecheri* QUATREFAGES.

i) *Spirorbis* sp. No. 1: With a left handed spiral shell. The center of the spiral inclines rather sharply. Body is reddish orange in colour, being distinctly different from that of *Spirorbis argutus* BUSH, and the operculum is also reddish orange. This species is very common in the shallow tide-pool, living exposed to the direct sunlight (Fig. 1, C).

ii) *Spirorbis argutus* BUSH: With a left handed spiral shell. The center of the spiral forms a rather weak inclination and looks like an earthenware morter. Body is thin and is reddish orange in colour while the tentacles are colourless and semiopaque, though outer surface of the operculum is of deep purple colour. This species is very common and is found attached to *Sargassum* grown in rather calm water (Fig. 1, A).

iii) *Spirorbis* sp. No. 2: With a left handed spiral shell. The shell substance is glassy and many of growth lines are clearly seen and the spiral looks somewhat like that of *Ammonite* in feature. This species is commonly found attached to the pebbles which lie below the low-tide-marks. According to Mr. KEIZO TAKAHASHI, this species is said to be new and he is going to report on it under the name of *Spirorbis asamushiensis* TAKAHASHI in the near future (Fig. 1, B).

iv) *Spirorbis pagenstecheri* QUATIEFAGES: With a right handed spiral shell. Three ridges are seen on the upper surface of the shell, being the middle one the most prominent, and the narrow areas between this ridge and the other two look as if to form shallow grooves. In some large individuals, the aperture of the shell is often directed upward. This species is very common, being found attached to the darker surface of the pebbles which lie below the low-tide-marks (Fig. 1, D).

II. HABITAT OF *SPIRORBIS*.

The present writer noticed the *Spirorbis* in such places as the shallow tide-pool, rather deep tide-pool, and on the surface of the rocks placed in the littoral zone, of the pebbles placed in the lower level than the low-tide-marks, of the Molluskan shell and of the algae such as *Sargassum*, etc. Thus it was found that the habitat of *Spirorbis* rather varies after the species.

a) The shallow tide-pool.

There are found many tide-pools in front of the Biological Station of Asamushi and they are all covered with seawater in the high-water time in spring and also even in ordinally days when the surging waves come over them, but in most of the time they are isolated from the sea. The depth of these tide-pools is within about 15 cms, and thus the temperature of the water there rises comparatively high, reaching 33–35°C in the summer time, while it falls lower than 0°C and thus the surface of the water freezes in the winter time. On Jan. 18th, 1939, the temperature of the sea-water underneath the frozen surface was measured –0.8°C.

Many *Spirorbis* are found inhabiting in such a shallow tide-pool as is shown in Figs. 2 & 3.

In Fig. 2, a number of minute white spots show the *Spirorbis* and they are only seen burried in the water while the others, representing the barnacles, *Chthamalus challengeri* HOEK, are seen on the level higher than the *Spirorbis* zone, namely they are usually exposed to the air. A periwinkle, *Littorina* (*Littorivaga*) *brevicula* (PHILIPPI), is seen here and there, being mainly exposed to the air.

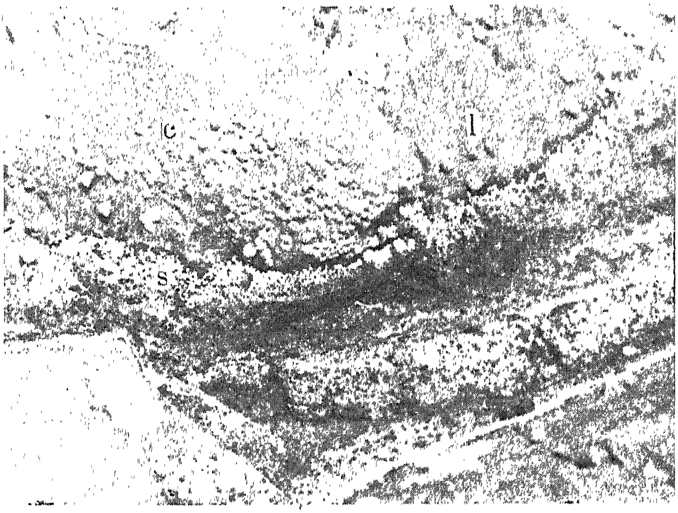

Fig. 2. Showing the aggregation of *Spirorbis* in the shallow tide-pool. s, *Spirorbis* sp. 1; c, *Chthamalus challengeri* HOEK; l, *Littorina* (*Littorivaga*) *brevicula* (PHILIPPI).

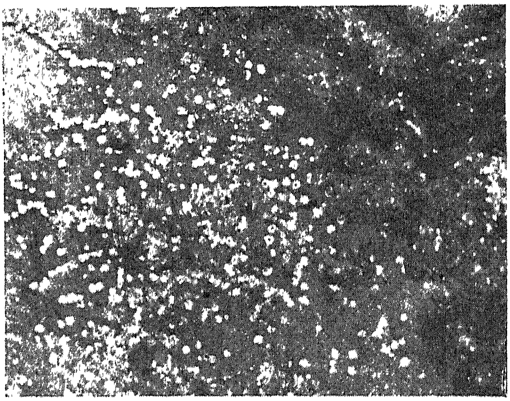

Fig. 3. Inhabitants in the shallow tide-pool. *Spirorbis* is the dominant species.

In some other shallow tide-pool which is about 1000 square cm wide and about 8 cm deep, many kinds of animals were observed (Fig. 3), and their names and the number of individuals were shown in the following list:

Patelloida pygmaea (DUNKER)	18
Littorina (*Littorivaga*) *brevicula* (PHILIPPI)	18
Thais (*Mancinella*) *tumulosa clavigera* (KÜSTER)	3
Other species of Gastropod	2

Acanthochiton rubrolinatus (LISCHKE)	2
Septifer virgatus (WIEGMANN)	2
Chthamalus challengeri HOEK	66
Spirorbis sp. 1.	2176
Anthopleura stella (VERRILL)	2

In the case of *Spirorbis*, about 208 adult larger shells were counted in an area of 5 cms square, but among them the living individuals were only 53, and the rest were all dead. And moreover, it was noticed that a number of very small young *Spirorbis* were found in addition to the adult individuals and they were counted 230 in the area of 5 cm square. Thus the *Spirorbis* was always the largest in number among the animals observed with the naked eye.

b) The vertical face of the rock standing in the littoral zone.

The distribution of the animals found in the littoral zone is rather complex, nearly all of them showing their proper zonations. And the writer has already reported on the zonation of the animals inhabiting in the littoral zone in the neighbourhood of the Asamushi Marine Biological Station (ABE, 1933, '40). On the vertical surface of the rock faced towards the east of the western pier of the Station (ABE, 1940, Table III), *Serpula* is zonating between the levels of about 20 cms and 40 cms below the mean-tide-level, and *Spirorbis* is seen only in the lower level than the *Serpula* zone. But the number of individuals is very scarce.

In general, *Serpula* zone is well developed on the vertical surface of the rocks that face to the west, especially to the north, while it is scarecely seen on the face of the rocks that face either to the east or especially to the south. Thus it may be considered that the *Serpula* zone is developed on the surface of the rocks that are less heated and less dried by the direct sunlight. The distribution of *Spirorbis* closely resembles that of a *Serpula*, *Pomatoleios crosslandi* PIXELL, being found on the vertical surface of the rocks as is shown in Fig. 4.

In Fig. 4, the zone inhabited by *Chthamalus chalengeri* HOEK is seen on the level upper than that of *Pomatoleios*. An algae, *Polysiphonia* is seen just on the level lower than the *Pomatoleios* zone. *Siphonaria japonica* DONOVAN is seen on the level lower than that of *Pomatoleios* and its egg-ribbon is also observed on the same level. (Here it must be noticed that *Siphonaria japonica* DONOVAN is commonly inhabiting on the level between the mean-tide-level and the *Pomatoleios* zone, but in the present case, the *Siphonaria* is found inhabiting on the level lower than the *Pomatoleios* zone. Such a case seems to occur from the reason that here the upper part of the *Pomatoleios* zone is flattened to keep a horizontal plane, consequently this rock face becomes to be heated by the direct sunlight, and thus the *Siphonaria* has migrated downward, occupying the level which is more shaded and more damp.)

In the case of *Spirorbis*, it is seen here and there on the level lower than the *Serpula* zone, being exposed to the air only in the time of low-tide. The species of *Spirorbis* is identical with that which inhabits in the shallow tide-pool, namely with *Spirorbis* sp. No. 1.

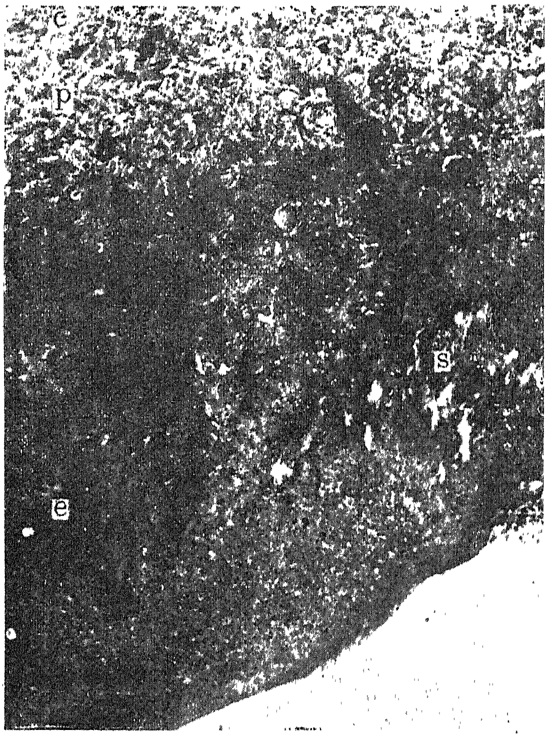

Fig. 4. Zonation of *Spirorbis* on the vertical rock-face.
c, *Chthamalus challengeri* Hoek; P, *Pomatoleios croolandi* Pixell; e, eggs of *Siphonaria japonica* Donovan; s, *Spirorbis* sp. 1:

c) The pebbles placed on the level lower than the low-tide marks.

The pebbly shore is found in the northern part and in the western of the Station, and there the pebbles are placed in the water deeper than the low-tide-marks and are covered with brown algae, mainly with *Sargassum Horneri*, when observed during the months of May and June.

The common inhabitants on such pebbles are Bryozoa, Serplid, *Spirorbis* and are sometimes sponges, sea-anemones, etc. The *Spirorbis* is found attached to some of the pebbles as shown in Fig. 5.

The *Spirorbis* is mainly found attached to the shaded side of the pebble. The present writer has measured the number of the *Spirorbis* and other organisms found on the pebble of somewhat cubical form and of about 10 cms. long on an edge, and the results obtained thus far are shown on Table I.

From Table I, it is seen that *Spirorbis* is found attached mainly on the shaded side of the pebble and moreover that *Spirorbis* is different in species according to the direction to which the wall of the pebble faces. Namely *Spirorbis* sp. No. 1 is seen only on the side walls but *Spirorbis* sp. No. 2 is found only on the under side of the pebble. The writer was not able to find any of *Spirorbis argutus* attached to such a pebble.

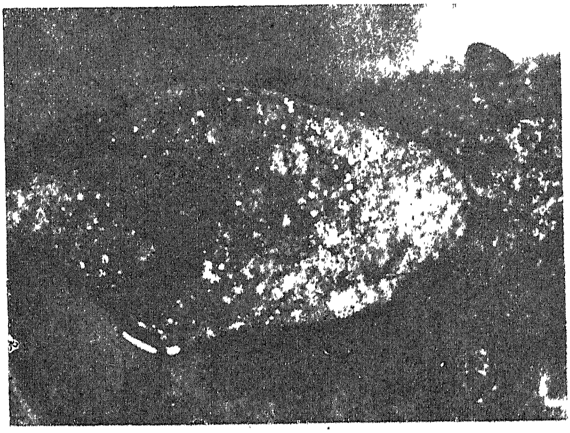

Fig. 5. *Spirorbis* on the pebbles laid in the level lower than low-tide-marks.

TABLE I. Sedentary organisms found on a pebble lying in the level lower than low-tide-marks.

Species Face of a pebble	*Spirorbis argutus*	*S.* sp. 1	*S.* sp. 2	*S. pagenstecheri*	Other organisms		
					Bryozoa	*Serpula*	Calcareous algae
Upper surface	0	0	0	0	0	0	++
Side wall	0	24	0	0	0	0	+++
Under surface	0	0	9	68	15	1	+
Total	0	24	9	68	15	1	+6

d) The thalli of *Sargassum*.

In the neighbourhood of the Station, *Sargassum Thunbergii* shows an association in the water-depth of about mean-tide-level, while *Sargassum Horneri* shows the same in the shore water deeper than the former. And the *Spirorbis* is seen attached to the thalli of the latter species of algae. But the writer could not find a very few individuals of the *Spirorbis* on *Sargassum* grown in the shore water where the waves splashes violently, but on the contrary, many *Spirorbis* were found on the *Sargassum* grown either in the shore where the waves splash less violently or especially in the calm tide-pool of about one metre deep. As for the species, it is limited only to *Spirorbis argutus* BUSH.

And it is characteristic of this species that it attaches mainly to the back side or to the under side of the thallus of *Sargassum* as is shown in Fig. 6.

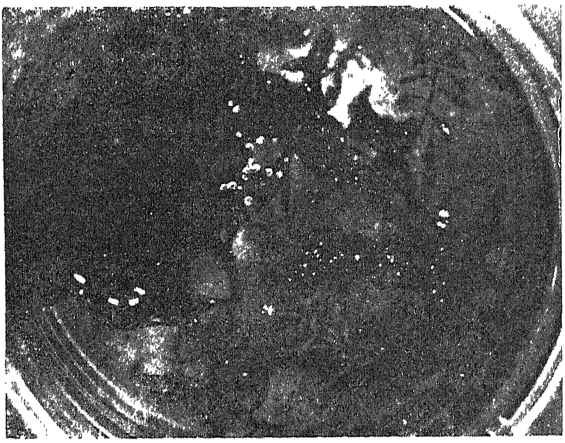

Fig. 6. *Spirorbis argutus* Bush attached to the thalli of *Sargassum* Horneri. (about × 1/2)

The writer has measured the number of *Spirorbis* attached to the thalli of *Sargassum* and the results obtained thus far are shown in Table II.

As is shown in Table II, more than 70% of the *Spirorbis* individuals are seen either on the back side or on the darker side of the thalli. And the total number of *Spirorbis* found on 13 pieces of the thalli was about 1160, and thus it is seen that the number of *Spirorbis* is very prominent of the *Sargassum* habitat.

TABLE II. Distribution of *Spirorbis argutus* BUSH on *Sargassum Horneri*.

No. of thalli		1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Larger individuals	Front side	31	32	49	10	15	35	36	18	16	8	0	0	0	250
	Back side	38	68	127	42	175	80	96	96	52	39	7	3	0	822
Smaller individuals	Front side	1	7	12	6	10	10	1	3	10	1	8	7	1	77
	Back side	2	11	31	12	23	21	7	7	13	12	26	8	8	187
Total		72	117	217	90	223	146	140	124	91	60	41	24	9	1336

Number of thalli was counted from base to top, thus No. 13 shows the youngest form bearing the smallest thallus among the others.

III. THE STRUCTURE OF THE BODY.

The general structure of the body of *Spirorbis argutus* has not yet been figurated except for the operculum and setae done by Bush (Bush, 1904, Figs. a and b). The present writer has examined the general structure of this species and figurated as shown in Fig. 7.

As is shown in Fig. 7, the *Spirorbis* bears 7 primary gill-filaments or branchiae and many of the secondary gill-filaments are given off in two series from the axis of the former. The number of the secondary ones is from about 7 to 10 on each side.

The branchiae are colourless in *Spirorbis argutus*, but are pale yellowish orange in *Spirorbis* sp. No. 1.

The operculum is seen on the tip of stalk (Fig. 9, a). The plate forming the operculum is deep purple in colour while the remaining part is colourless and semi-opaque. In some individuals, the eggs were seen being contained within the brood-pouch which is formed at the terminal end of the operculum (Fig. 7).

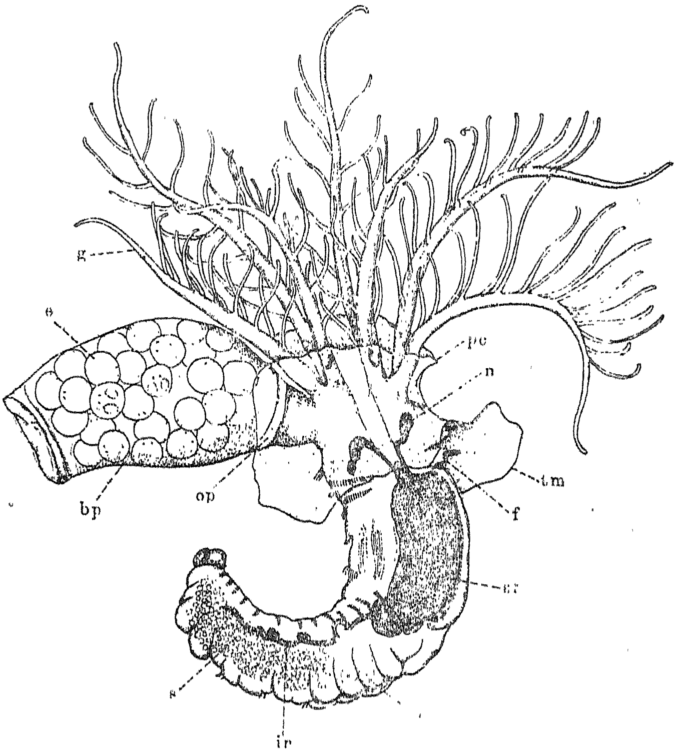

Fig. 7. The general features of body of *Spirorbis argutus* BUSH. g, gill filament; pc, peristomial collar; op, operculum; bp, brood-pouch; e, egg; tm, thoracic membrane; f, foot with bundle of setae; st, stomach; in, intestine; n, thoracic nephridia; o, ova; s, spermatozoa.

The peristomial collar is colourless in the case of *Spirorbis argutus* in general, but it is pale orange colour in *Spirorbis* sp. No. 1. The margin of the peristomial collar bears many denticles.

The thorax is reddish orange in colour and there are seen three pairs of parapodia, each provided with a bundle of setae, and these setae are often projected from the parapodia, the most of their basal parts being burried within the same.

Two series of unici are also seen on the ventral side of the thoracal region (Fig. 8, C and D). The other sets of the short unici are arranged on the ventral side of the tail region. The number of the band formed by the latter kind of spicules is 14, and it may be possibly the same with that of the segments forming the tail region. The shapes of the unici are shown in Fig. 8, E and F.

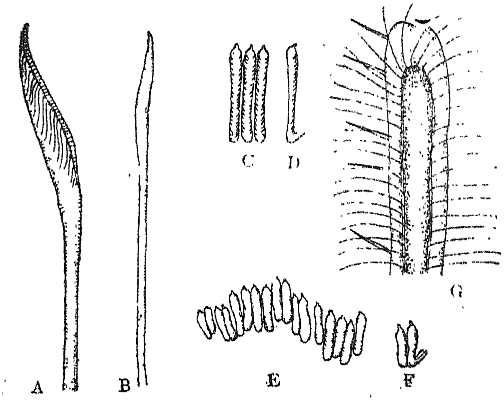

Fig. 8. Setae and unici of *Spirorbis argutus* BUSH.
A and B, setae from parapodium; C and D, unici from thoracic band; E and F, unici from the tail region. (× ca. 400)

The tail region is also reddish orange in colour and its posterior end forms a structure like a sucker.

Speaking of the internal organs, the stomach is large and prominent, being tinged with deep blackish purple. A single pair of thoracic nephridia of deep purple colour is seen in the anterior part of the stomach and they open by means of median dorsal pore situated beneath the peristomial collar. The intestine is somewhat meandering, running along the ventral side of the tail. The anus open on the ventral side close to the tail end which is sucker-like in structure.

IV. THE BEHAVIOR.

a). The feeding behavior and the excretion.

The *Spirorbis* are usually stretching out their gill-filaments, and produce the water current by the movement of cilia which are arranged along the median groove of the gill-filament (Fig. 8, G). And when the food particles come near the secondary gill-filament, it catches them and carries towards the mouth. And thus the gill-filament acts the roles of food capture and of feeling in addition to respiration.

The area surrounding the mouth is furnished with cilia densely set, by means of which the foods are swifted into the mouth.

When the carmine granules are poured on the gill-filament they will be carried into the mouth, but when the sand grains are added to the same it will be suddenly withdrawn and thus they are taken away from the mouth.

The foods of the *Spirorbis* consist mainly of minute organisms, such as floating diatoms, Protozoa, etc.

The excrements are first forced out from the anus but afterwards they are carried to the tail end then are carried further along the dorsal side of the tail region as is shown in Fig. 13, H. Finally the excrements are set free from the body by the movement of gill-filaments. Such a manner of defecation occurs very often but it is the case with some individuals. Of the excrement, only one fecal mass is formed commonly at one time, but sometimes 2 or 3 of these are produced continuously. Thus many fecal masses are to be seen in the neighbourhood of the shell aperture when the animal was left quietly in water for some duration of time as is shown in Fig. 9, A.

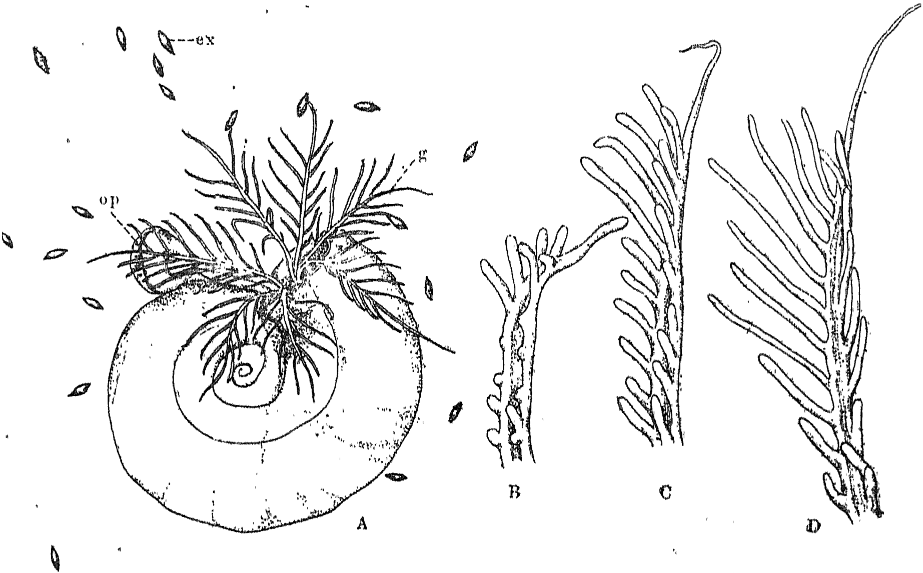

Fig. 9. Egestion of *Spirorbis argutus* and regeneration of the gill-filament. A, egestion; op, operculum; g, gill-filament; ex, excrement; B, a gill-filament, secondary gill-filaments are faded away and lost (Dec. 21st); C, the same gill-filament seen on Dec. 28th, half regenerated; D, the same on Jan. 12th, nearly recovered normal state.

b) The regeneration of the gill-filaments.

The gill-filaments of *Spirorbis* are fully stretched under the normal conditions (Fig. 9, A); but they are shortened and wrinkled under the bad conditions of life such as the decrease of oxygen consumption in the surrounding water, etc. And when *Spirorbis* is left long under such bad conditions, the gill-filaments are wrinkled and the secondary gill-filaments are shed off from the primary gill-filament, and moreover the distal parts of the primary gill-filaments are also lost.

But when such animal is transfered into the better conditions of life the gill-filaments once lost will regenerate and become normal within certain days.

Fig. 9, B shows a gill-filament which has lost the most of their secondary gill-filaments and only a few of these are remaining in the form of knobs. This animal which showed such features in the gill-filaments on Dec. 12th was transfered into the better condition, and thus the same gill-filament has regenerated to such a degree as shown in Fig. 9, C when observed on the 28th of the same month. Afterwards the gill-filaments have much more regenerated and have shown nearly the normal feature on Jan. 12th (Fig. 9, D). From the above observation it is seen that the gill-filament took about one month to recover its secondary gill-filaments once lost under the laboratory conditions.

c) The reaction of the gill-filament to sound and light.

Spirorbis is very sensitive to some sound and vibration and their gill-filaments will be withdrawn within the shell very quickly even when the vessel in which the *Spirorbis* was cultured is knocked very slightly.

But *Spirorbis* do not show any shading reaction to the sudden change of the intensity of light both in the natural habitat and in the laboratory.

V. THE REPRODUCTION OF *SPIRORBIS ARGUTUS* Bush.

a) Eggs and spermatozoa.

Spirorbis is a hermaphrodite animal as is generally known. The gonard is seen in the tail region and the ovary is found anterior to the testis and the testis occupies the greater posterior part of the tail region. The *Spirorbis* which bears many larvae within the brood-pouch at the terminal end of the operculum also contain the younger eggs within the ovary. The eggs found in the ovary are about 95–99 μ in diameter and are pale yellowish orange in colour (Fig. 10, A). The larvae found in the brood-pouch reach the stages shown in E or F of Fig. 11. It is often noticed that the larvae are rotating within the egg-capsule of about 130–140 μ in diameter.

The spermatozoa found in the testis bear the head of nearly ellipsoidal form and the latter is proved with a long process, and many of these spermatozoa are aggregated in such a manner as is shown in Fig. 10, B. The tail of the spermatozoon is usually moving slowly, and thus the aggregated spermatozoa also move slowly as a whole. Of the spermatozoon, the shorter diameter of the head is about 1 μ and the process of the same is about 20–21 μ long and the tail is about 110–120 μ long (Fig. 10, C).

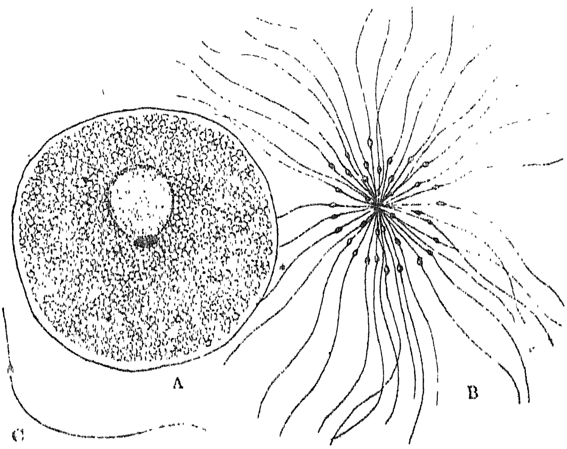

Fig. 10. Egg and spermatozoa found in the gonard of *Spirorbis argutus* Bush. (× ca. 400)
A, egg; B, spermatozoa aggregated; C, a spermatozoon.

b) Development of the larvae within the brood-pouch.

The eggs first formed in the ovary are carried into the brood-pouch which may be formed at the anterior end of the operculum. But, at any rate, the eggs are seen within the brood-pouch and each of these eggs is contained within an opaque capsule as is seen in Fig. 11, A. The eggs found in the pouch seem to have been already fertilized.

The division of an egg occurs within the brood-pouch, but it is difficult to observe externally the process of cell division through the egg-capsule and the brood-pouch. Before long, the larvae will become able to move slowly within the egg-capsule by means of cilia, and within a few days two pairs of eye-spots will appear in the region as shown in Fig. 11, A. (It was seen on Dec. 20th.)

Within three or four days when the above stage passes, a pair of small white spots will appear as shown in Fig. 11, B. (It was first seen on Dec. 23rd, when the temperature of seawater was 12.3°C). These white spots are the origin of the shell glands and are found on the ventral side of the thoracic region of the larva. Each of the shell glands becomes larger day by day (Fig. 11, C shows the stage seen on Dec. 26).

The larva of such a stage is found within an egg-capsule which is about 160 μ in the larger diameter and 140 μ in the shorter diameter and 1.2 μ in thickness. Of the body it may be distinguished three regions of head, thorax and tail.

In the head region, 2 pairs of the larger and the smaller eye-spots are clearly seen on the dorsal side. The colour of the eye-spot is reddish calotin. The larger eye-spot is about 14 μ in the longer diameter and about 4–5 μ in the shorter.

In the thoracic region a pair of the shell glands are seen, each of which is white by the reflecting light but greenish brown by the transparent light.

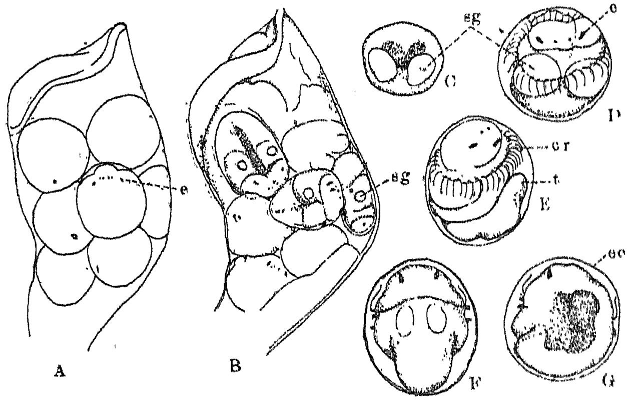

Fig. 11. The eggs contained within the brood-pouch and their development. A, B and C (× ca. 60); D–G (× ca. 96). e, eye-spot; sg, shell gland; cr, ciliary band in the thoracic region; t, tail folded ventral wards; ec, egg capsule.

On the boundary line between the head region and the thoracic, a ciliary band is seen around the neck and those cilia are distinctly longer and stouter (33–44 μ long) than those (5–6 μ long) which cover the thoracic region and the tail. The area situated just posterior to the ciliary ring is tinged with pale yellowish orange (Fig. 11, D–G).

The tail region is turned ventrally towards the thorax and is folded somewhat showing a segmentation slightly developed, and the segments are sometimes shortened and sometimes are elongated a little. The tail region is semi-opaque and is faintly coloured with yellowish orange (Fig. 11, D and E).

The larvae always move the cilia and rotate slowly within the egg-capsule. The hatching of the larvae was seen in a few days after they reached the stage just above mentioned (on Dec. 30th).

c) The hatching.

When the shell glands are fully developed the larva will become to appear white and thus they may be easily observed with naked eye. Wenn the larva reached such a stage, the capsule of the brood-pouch will be separated from the operculum in such a manner as shown in Fig. 12, A.

The egg-capsule will be broken possibly by the act of the tail of larva, and in fact it was once observed that some larvae pushed themselves out from the egg-capsules using their tail ends. When the capsule of brood-pouch is separated from the operculum, a number of larvae are freed into the water and begin to swim, but some are pushed into the water in such state as still contained within the egg-capsule. At any rate, the capsule forming the brood-pouch will be divided perfectly into two pieces (Fig. 12, B).

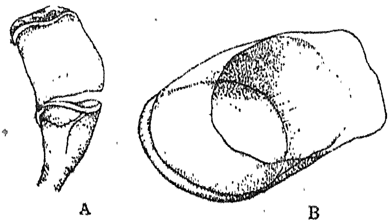

Fig. 12. The capsule forming the brood-pouch.
A, showing the capsule just separating from the operculum; B, capsule separated from the operculum.

d) The growth of the larva after hatched.

The larvae just hatched are able to swim actively, moving their cilia found on the ciliary ring. The tail is stretched enough when the larva swims. The body of the larva just hatched is about 320 μ long, and 140–150 μ wide at the thorax (Fig. 13, A). The larva stops sometimes to swim, licking the bottom of the vessel by means of its mouth parts, and lifting upward the tail. Even in the time of resting, the cilia are moved swiftly. The larva seems to adhere to some foreign body by means of operculum. In the time of resting, the tail is moved in all directions and often it is shortened, thus the body length becoming about 220 μ.

The larva bears 5 low knobs distributed in the surrounding area of the mouth, and they are destined to develop into the gill-filaments later (Fig. 13, A, B and C).

In the morning next to the hatching, the larva will settle down on some solid substance by secreting the calcareous shell as shown in Fig. 13, E.

Fig. 13, D shows the process of secretion of the shell which occur during the early stage of larval development.. Namely, the substance forming the shell is secreted from the shell gland in the thorax, and the shell is made first around the thorax and afterwards also around the tail. In the stage of D in Fig. 13, the tail end is still exposed not being covered

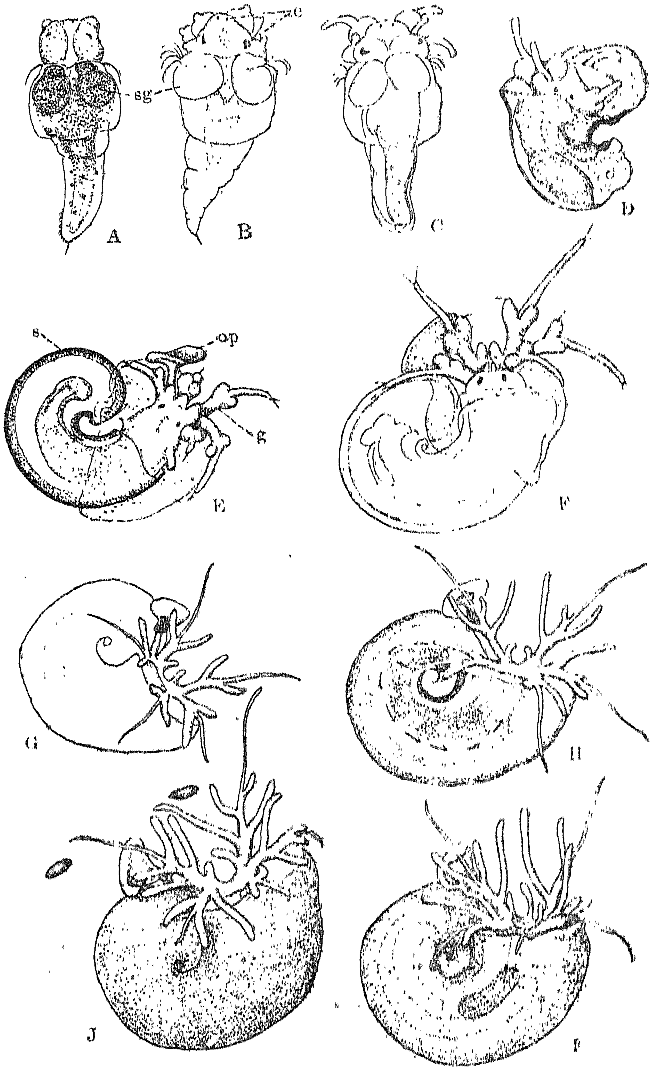

Fig. 13. Growth of larva of *Spirorbis argutus* Bush after hatching. A–F (× ca. 96). G–J (× ca. 60). D is seen from the ventral side. sg, shell gland; e, two pairs of eye spots; s, shell; op, operculum; g, young gill filament. Arrows in Fig. H show the paths of excrements.

by the shell while the thorax was already surrounded by the same. The shell completed is spiral in form and covers even the head region.

The larva one day old has an operculum and five gill-filaments each of which bearing a pair of knobs destinated to give rise to the secondary gill-filaments (Fig. 13, E). In addition to the above mentioned 5 gill-filaments, a pair of short gill-filaments are seen just growing near the mouth. Thus the number of the gill-filaments becomes 7 in all.

The feeding is seen early in this stage. A pair of gill-filaments situated close to the mouth are moved very actively and thus the foods are first carried towards the mouth by the current caused by the cilia found on them; then they are swept into the mouth by means of the gill-filament mentioned above.

A membraneous collar is usually seen of the larva in such stages as shown in Fig. 13, E, etc., and it is folded and withdrawn inside of the shell when the larva hide itself within the shell.

Two days after the hatching, the larva is developed to the stage as is shown in F of Fig. 13. In this stage, 2 spines are seen at the terminal end of each of the primary gill-filaments and one spine at the terminal end of each of the secondary gill-filaments.

Fig. 13, G, H, I and J show the course of development of the same larva which, however, is different from the larvae shown on Fig. E and F. The larve shown in Fig. G was hatched on Dec. 15th and was drawn on Dec. 23rd, and the figures H, I, and J were drawn of the same larva on Dec. 26th, Jan. 6th and Jan. 23rd respeetively.

The number of the secondary gill-filaments in the case of H is 3 and they are arranged alternately. While in J, they are four in number. It is also seen that a pair of the gill-filaments found near the mouth did not performed any further growth in these stages.

e) The time of reproduction of *Spirorbis*.

It is generally known that the time of reproduction of some marine animals is largely decided in accordance with the temperature of the sea-water that shows the seasonal cycle, and moreover it stands in certain relation to the lunar phases that produces the lunar cycle in the reproduction of some animals at least (Abe, 1940). The writer has noticed that some phases exist relating to the time of reproduction in the case of *Spirorbis*.

But he was unable to find any definite cycle that exists when the *Spirorbis* spawns every month throughout the year. The *Spirorbis* spawn their larvae at the temperature of 5–6°C in winter and do the same even at 32°C in summer in the tide-pool. Also the writer was not able to find out any definite relation that exists between the lunar cycle and the reproduction period of this animal.

It seems to be highly probable that the time of reproduction of *Spirorbis* may be decided according to the physiological conditions of each individual, and may not be much influenced by the enviromental conditions in the natural habitat.

VI. THE GROWTH OF SHELL.

Several number of glass-slides were placed in a glass vessel of 20 cm in diameter and 15 cm in depth, and some amount of seawater was poured constantly into it by means of a glass tube led from the water tank of the aquarium, and thus some kinds of Diatoms were also carried into the vessel and there they have reproduced so luxuriantly that they covered all over the glass-slides within several days. At the same time, some kinds of animals as *Spirorbis*, *Serpula*, Foraminifera, compound Ascidia, etc. were also found attached to the same. In this case the *Spirorbis* was found to be dominant. The specific name of this kind of *Spirorbis* is not yet clear, but it may be *Spirorbis* sp. No. 1, which is rather common in the shallow tide-pool. And it is clear that the present species is not identical with any of *Spirorbis argutus*, *Spirorbis pagenstecheri*, *Spirorbis* sp. No. 2 (*Spirorbis asamusiensis* TAKAHASHI).

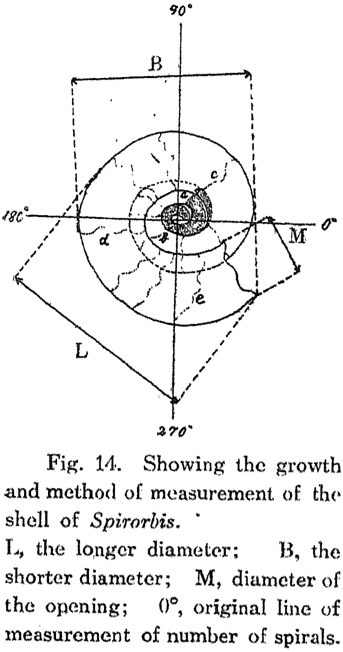

Fig. 14. Showing the growth and method of measurement of the shell of *Spirorbis*.
L, the longer diameter; B, the shorter diameter; M, diameter of the opening; 0°, original line of measurement of number of spirals. a, Aug. 20th; b, Aug. 27th; c, Sept. 3rd; d, Sept. 9th; e, Sept. 17th.

At any rate, the writer had the chance to observe the growth of *Spirorbis* under the microscope, using the glass-slide thus prepared, and was able to sketch their feature, to measure their sizes and to count the number of spirals of the shell. The method of measurement of the shell is shown in Fig. 14, and the results obtained thus far are shown on Table III, IV and V.

TABLE III. Growth of *Spirorbis* sp. No. 1 and No. 2.

Date	No. 1.						No. 2.					
	L in mm	B in mm	M in mm	π	$\overset{0}{\mathrm{R}}$	o	L in mm	B in mm	M in mm	π	$\overset{0}{\mathrm{R}}$	o
Aug. 27												
,, 31	0.29	0.21	0.10		2	28	0.29	0.23	0.09		2	37
Sept. 3	0.29	0.22	0.10		2	55	0.29	0.27	0.11		2	88
,, 7	0.29	0.25	0.11		2	77	0.35	0.28	0.14		3	30
,, 9	0.33	0.29	0.12		3	34	0.39	0.29	0.15		3	74
,, 12	0.42	0.28	0.14	1	0	13	0.42	0.30	0.16	1	0	27
,, 14	0.45	0.32	0.18	1	0	43	0.43	0.32	0.17	1	0	44
,, 17	0.47	0.37	0.20	1	0	81	0.46	0.37	0.18	1	0	85
,, 21	0.48	0.46	0.22	1	1	37	0.57	0.43	0.22	1	1	45
,, 30	0.71	0.56	0.25	1	2	65	0.70	0.57	0.27	1	2	70
Oct. 20	1.08	0.86	0.37	2	3	45	1.16	0.92	0.39	2	1	87
,, 29	1.14	0.93	0.40	2	3	77	1.19	0.96	0.42	2	1	37

TABLE IV. Growth of *Spirorbis* sp. No. 3 and No. 4.

Date	No. 3.						No. 4.					
	L in mm	B in mm	M in mm	π	$\overset{0}{\mathrm{R}}$	o	L in mm	B in mm	M in mm	π	$\overset{0}{\mathrm{R}}$	o
Aug. 20	0.26	0.23	0.09		3	44						
,, 23	0.31	0.24	0.11		3	64	0.35	0.25	0.12	1	0	0
,, 25	0.34	0.23	0.11		3	86	0.40	0.25	0.13	1	0	20
,, 27	0.37	0.23	0.13	1	0	11	0.47	0.25	0.17	1	0	41
,, 29	0.38	0.24	0.14	1	0	34	0.51	0.31	0.18	1	0	76
,, 31	0.41	0.28	0.16	1	0	53	0.51	0.41	0.22	1	1	20
Sept. 3	0.42	0.33	0.17	1	1	5	0.53	0.43	0.24	1	1	50
,, 5	0.52	0.42	0.20	1	2	11	0.64	0.45	0.25	1	2	15
,, 7	0.54	0.44	0.22	1	2	53	0.72	0.49	0.28	1	2	56
,, 9	0.62	0.48	0:26	1	3	29	0.75	0.58	0.30	1	3	11
,, 12	0.72	0.54	0.30	2	0	5	0.78	0.63	0.30	1	3	49
,, 14	0.80	0.61	0.34	2	0	52	0.83	0.68	0.32	1	3	73
,, 17	0.91	0.68	0.36	2	1	5	0.94	0.73	0.35	2	0	22
,, 21	0.97	0.80	0.37	2	1	73	1.02	0.76	0.37	2	0	47
,, 30	1.25	0.99	0.37	2	2	47	1.03	0.78	0.35	2	0	62

TABLE V. Growth of *Spirorbis* sp. No. 5 and No. 6.

Date	No. 5.						No. 6.					
	L in mm	B in mm	M in mm	π	R	o	L in mm	B in mm	M in mm	π	R	o
Aug. 20	0.40	0.30	0.17	1	0	60	0.71	0.48	0.31	2	0	31
,, 23	0.52	0.40	0.22	1	1	42	0.86	0.70	0.34	2	1	11
,, 25	0.62	0.41	0.27	1	1	81	0.87	0.67	0.34	2	1	25
,, 27	0.66	0.48	0.27	1	2	41	0.88	0.68	0.34	2	1	37
,, 29	0.70	0.62	0.28	1	3	12	0.96	0.74	0.37	2	1	67
,, 31	0.81	0.66	0.32	1	3	57	0.97	0.75	0.35	2	2	1
Sept. 3	0.92	0.70	0.38	2	0	43	1.05	0.84	0.35	2	2	41
,, 5	1.02	0.85	0.43	2	1	15	1.10	0.91	0.35	2	2	71
,, 7	1.09	0.91	0.43	2	1	51	1.12	0.93	0.36	2	3	3
,, 9	1.23	0.97	0.47	2	2	14	1.16	0.98	0.38	2	3	32
,, 12	1.25	1.03	0.46	2	2	51	1.21	1.00	0.41	2	3	55
,, 14	1.31	1.07	0.48	2	2	70	1.24	1.04	0.42	2	3	70
,, 17	1.35	1.12	0.48	2	3	12	1.30	1.10	0.44	3	0	18
,, 21	1.37	1.23	0.48	2	3	47	1.39	1.13	0.47	8	0	49

The writer has measured about 30 individuals of *Spirorbis* but here will be given the data obtained from 6 of these as shown on Table III, IV and V.

In Table III, IV and V, means the longer diameter of the spiral shell, and B represents the shorter. But in some cases B does not denote the shorter diameter because it was obtained by the method as is shown in Fig. 14. M represents the diameter of the shell aperture. As for the number of spirals, it is represented by π, R and o, where π=390°, R=90° and o=degrees. Therefore, for instance, 1π 2R 30° represents 570 degrees measured from the original line 0° in Fig. 14.

As for the temperature of seawater, it ranged from 24°C to 26°C during the days of August and also early in September, but it decreased suddenly since the middle of September, showing 20–22°C and it was about 17–19°C in late September. Therefore the influence of temperature given upon the growth of the *Spirorbis* in the present case seems to be rather complex, but from the Table III, IV and V, it is known that the rate of growth is about 0.023 mm in the longer diameter per day, and thus the shell may reach 0.69 mm within one month and 2.08 mm within 3 months. The growth rate of spirals of the shell may be 15.3 degrees per day and thus it may reach to 1π 1R 9° within one month and 3π

3R 27° within 3 months. In such a way, it may be roughly culcurated that the *Spirorbis* attains its adult stage within three months at least.

VII. THE GENERAL CONSIDERATION.

1. The distribution of *Spirorbis*.

According to BENHAM (1922), it is stated that "*Spirorbis* is the oldest unequivocal representative of the Polychaeta, as its tube are found more or less abundantly in the Silurian and other Palaeozoic strata".

In the recent time, *Spirorbis* is one of the most common animals found in the sea. In the neighbourhood of Asamushi, it is seen adhearing to algae, pebbles and rocks which lie in the tide-pool and to the vertical surface of rocks found on the seashore, and moreover, to the shells of various kinds of Mollusca.

Spirorbis is an animal that lives in the water and on the level lower than that of meantide at least. And this is in accordance with the absence of the means to protect its body from drying but not with the respiration directly, because the *Spirorbis* do not die even when it was placed in the air for a day long in the laboratory.

Spirorbis argutus BUSH is a species first recorded from Japan, basing on the observations upon two individuals which were found attached to red algae grown in the sea of 34 fathoms deep on May, 1900 (MOORE and BUSH, 1904). But this species is also seen on the talli of *Sargassum*, in general in the neighbourhood of Asamushi. Though this species is usually found on *Sargassum*, it is limited only on those grown in the calm water. The reason may be concerned to the behavior of the larva. The larva of *Spirorbis* is not able to adhere to the tallus of algae when the sea is rough, as the attaching power of the young operculum is rather weak. The writer has observed many larvae adhering to the bottom of vessel by means of their young operculum, and in such a case as the vessel is slightly agitated and thus the water has moved slightly, then they will be freed from the bottom and swim about here and there, though they attach again to the same in a few seconds.

From Table II mentioned above, it is clear that the *Spirorbis* of the larger sizes are mainly found attached to the older talli of *Sargassum* while the smaller are to the younger talli. And it seems to be interesting to study such relation existing between the *Spirorbis* and *Sargassum*.

2. The setae of *Spirorbis argutus*.

In general, the setae of Polychaeta may be classified into three groups, viz. (1) simple; (2) jointed; and (3) uncini. Of the setae of *Spirorbis argutus*, BUSH states as follows: "Thorax with three fascicles of setae and two rows of uncini on each side. All the setae simple tapered blades (Fig. b), so small and delicate as not to be clearly seen under a 7 objective, showing no serrations on the edge of the blade even under 1/10 oil immersion. Uncini very narrow, linear, the teeth appearing as but slight roughnesses on the surface, even under the highest power. Abdominal uncini in the first series or segment not appreciable smaller than those on the thorax; setae not found (MOORE and BUSH, 1904)."

In the case of *Spirorbis argutus* found at Asamushi, the setae grown on the parapodia are all of the simple type, but there are two kinds of these, namely the one kind is sharply tapered blade with no serration on the edge (Fig. 8, A), and the other is the same but provided with serrations (Fig. 8, B). The uncini are arranged in two rows in the thoracal region and each is narrow and linear with a sharp shorter end and with minute serration on one side (Fig. 8, C and D). The abdominal uncini are smaller than the thoraca (Fig. 8, E and F).

3. The reproduction of *Spirorbis*.

There are many studies concerning the breeding season of Polychaeta, and it is known that the breeding seasons of many species of Polychaeta are clearly related to the lunar periodicity, as in the case of *Ceratocephale osawai* (IZUKA, 1903), *Lysidice oele* (HORST, 1905), *Nereis dumerilii* (HEMPELMAN, 1911), *Nereis limbata* (LILLIE and JUST, 1913), *Eulalia punctifera* (FAGE and LEGENDRE, 1926) (see AMIRTHALINGAM, 1928 and ABE, 1940) and *Arenicola cristata* STIMPSON (OKADA, 1941).

But in the case of *Spirorbis argutus*, the writer was not able to find out exactly the relation between the breeding season and the lunar periodicity. And he thinks that it is caused by the fact that they are living attached to the thallus of algae, and thus the depth of water in which they live is almost constant both in the high-tide and in the low-tide. In other words, the enviromental conditions around the *Spirorbis* do not show any marked difference both in the spring tide and the neap tide.

Of the larval stages of Polychaeta, there are many studies made by such workers as CLAPARÈDE (1863), AGASSIZ, A. (1866), CLAPARÈDE and MEZINKOW (1869), GRAVELY (1909, a and b), HERPIN (1926), WILSON, D. P. (1928, 1932) (see WILSON, 1928, 1932) and OKADA (1941). But of the larvae of *Spirorbis* it seems not to be studied much, and at least such is the case with that of *Spirorbis argutus*.

The behavior of the larva seems to differ after the species of *Spirorbis*, and the larvae of *Spirorbis argutus* attach mainly to the talli of *Sargassum* while the same of other species do not attach to this kind of algae. Thus it may be interesting to solve the reason why the larvae of *Spirorbis argutus* select the talli of *Sargassum* to attach and the others not so. The *Spirorbis* which attaches to the glass wall of aquarium seems to be limited to one species, that is, possibly *Spirorbis* sp. No. 1.

The free swimming period of the larva of *Spirorbis argutus* seems to be 10–12 hours in general, and it is rather short when compared with those of the larvae of Polychaeta. The aggregation of the *Spirorbis* may probably due to the short floating period of the larva.

SUMMARY

1. The habitat of *Spirorbis* is different after the species and *Spirorbis* sp. No. 1 is found in the shallow tide-pool and also on the vertical surface of the rocks that lie on the levels between the *Pomatoleios* zone and the low-tide-marks. And this species is the most dominant among the inhabitants of the shallow tide-pool, and the number of individuals counted was about 300 in each area of 5 cm square.
2. On the level lower than the low-tide-marks, *Spirorbis* sp. No. 1 is seen attached to the upper surface of pebbles, while *Spirorbis pagenstecheri* QUATIEFAGES and *Spirorbis* sp. No. 2 are seen on the under side of the same. They are also dominant among the species inhabiting attached to the pebbles.
3. *Spirorbis argutus* BUSH are mainly found attached to the thalli of *Sargassum Thunbergii* (KUNTZE) OKAM. grown in rather calm water. The number of individuals attached to 13 pieces of thalli of this kind of algae was 1300 and from 70 to 76% of them were found on the under side, namely on the shaded side of the thalli.
4. The general structure of *Spirorbis argutus* was described. The *Spirorbis* have 7 primary gill-filaments, each bearing from 7 to 10 of the secondary, and they are nearly colourless in *Spirorbis argutus* but are faintly yellowish orange in *Spirorbis* sp. No. 1.
5. The setae found on the parapodia of *Spirorbis argutus* are all of the simple type, but two kinds of them may be distinguished, namely, the one consists of a sharp tapered blade without any serrations on its edge and the other is that with serration. Two series of uncini are seen in the thoracal region, and the abdominal uncini is seen on each of the segments forming the tail region.

6. The feeding of *Spirorbis* is performed by the current caused by the cilia found on the gill-filaments grown around the mouthpart, and also by the movement of the secondary gill-filaments. Foods may possibly be minute organisms, such as floating Diatoms, Protozoa, etc.

7. The gills are lost when the animal is set under the bad condition, but it may recover the normal state within about one month.

8. *Spirorbis* is very sensitive to some sound or vibration, but do not show any avoiding reaction to the sudden change of the intensity of light. *Spirorbis* do not also exhibit any phosphorescens.

9. The eggs and spermatozoa found within the gonard were examined in the case of *Spirorbis argutus*. The fertilization seems to occur internally.

10. In the early stage of the larva, a pair of shell-glands appear first in the stage of 3 or 4 days after the previous stage, in which two pairs of eye-spots are formed.

11. The larva just hatched is about $320\,\mu$ long and 140-$150\,\mu$ wide. It swims actively mainly by the movement of cilia which are found along the boundary line between the head and thorax. The larva has 5 short knobs in the area surrounding the mouth and they are destined to give rise to the gill-filaments.

12. In the morning next to the hatching, the larva settles down on some solid body by secreting calcareous shell substance. The larva of this stage has an operculum and 5 gill-filaments provided with a pair of knob-like secondary gill-filaments and a pair of short gill-filaments near the mouth.

13. Formation of the spiral tube begins first in the thoracal region and advances tailwards and then headwards.

14. Of the spiral tube the mode of growth was observed. The diameter of the opening of the tube increases about 0.7 mm in one month and the spirals increase about 460 degrees in one month, therefore the shell of *Spirorbis* reaches its adult size within 3 months at least.

15. *Spirorbis argutus* spawn the larva in the water of 5-6°C temperature in winter and of 32°C in summer. The writer was not able to find any relation existing between the lunar cycle and the breeding season of this animal.

REFERENCES

ABE, NOBORU (1933). The Colony of Limpet (*Acmaea dorsuosa* GOULD). Sci. Rep. Tôhoku Imp. Univ., 4th Ser., Biol., Vol. VIII, No. 2, 1933, pp. 169-187.

ABE, N. (1940). The Homing, Spawning and Other Habits of a Limpet, *Siphonaria japonica* DONOVAN. Ibid. Vol. XV, No. 1, 1940, pp. 59-95.

AMIRTHALINGAM, C. (1928). On Lunar Periodicity in Reproduction of *Pecten opercularis* near Plymouth in 1927-28. Journ. Mar. Biol. Assoc. (N.S.) Vol. 15, 1928, pp. 605-641.

BENHAM, W. B. (1922). Archiannelida, Polychaeta and Myzostomaria. The Cambridge Natural History, Vol. 2, 1922, pp. 241-344.

MOOR, J. P. and BUSH, KATHARIN, J. (1904). Sabellidae and Serpulidae from Japan, with Descriptions of New Species of *Spirorbis*. Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. LVI, 1904, pp. 157-179.

OKADA, KATSUHIRO (1941). The Gametogenesis, the Breeding Habits, and the Early Development of *Arenicola cristata* STIMPSON, a Tubicolous Polychaete. Sci. Rep. Tôhoku Imp. Univ., 4th Ser., Biol., Vol. XVI, No. 2, 1941, pp. 99-145.

WILSON, DOUGLAS P. (1928). The Larvae of *Polydora ciliata* JOHNSTON and *Polydora hoplura* CLAPARÈDE. Journ. Mar. Biol. Assoc., Vol. XV, (N. S.), 1928, pp. 567-604.

WILSON, D. P. (1932). The Development of *Nereis pelagica* LINNAEUS. Ibid. Vol. XVIII, (N. S.), 1932-33, pp. 203-217.

STUDIES ON THE CALCAREA OF JAPAN

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(With Plates XI–XVIII and 27 Text-figures)

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CONTENTS

I. Introduction 353
II. Description of Species 367
  A. Homocoelidae 367
  B. Leucascidae 391
  C. Leucaltidae 394
  D. Minchinellidae 395
  E. Sycettidae 396
  F. Heteropiidae 413
  G. Grantiidae 429
  H. Amphoriscidae 458
  I. Lelapiidae 458
III. Distribution of Calcarea in Japan 459
  A. Horizontal Distribution 462
  B. Bathymetrical Distribution 469
IV. Keys to the Genera and Species of Calcarea found in Japan 470
V. List of Literatures 479
IV. Explanation of the Plates 488

I. INTRODUCTION

The first record on the calcareous sponges of Japan was made by E. HAECKEL in 1872. In his monograph on calcareous sponges he has described four species, viz. *Ascilla japonica* HAECKEL, *Leucyssa spongilla* HAECKEL, *Sycetta cupla* HAECKEL, and *Sycandra raphanus* O. SCHMIDT, these specimens being collected by GILDEMEISTER in Tôkyô Bay. The first three species were proper to Japan, while the last was cosmopolitan.

In 1892, DÖDERLEIN described an interesting Calcarea, *Petrostroma schulzei*, basing his description upon a specimen obtained by himself from the Sagami Sea.

In 1894, Professor HARA reported on a new Calcarea, *Lelapia nipponica*, using a single specimen obtained by the late Prof. IJIMA at Hazama in the Sagami Sea. This is the first report that made by a Japanese dealing with the calcareous sponges obtained from the Japanese waters.

Thus, up to 1900 our knowledge concerning the Calcarea-fauna of Japan was very scanty, the number of calcareous sponges recorded from Japan being only six in all.

In 1916, Professor HÔZAWA recorded seven species that belong to the Family Heteropiidae. The materials which served for his study were those collected from the Sagami Sea. Of the said seven species, six were new to science.

In 1906, the United State Fisheries Steamer "Albatross" secured several specimens of calcareous sponges during her cruise in the northwestern Pacific. Prof. HÔZAWA examined these specimens and has reported on in 1918. In this report he has treated thirteen species, seven of which were new to science and eight were newly added to the Calcarea-fauna of Japan. The localities where the calcareous sponges obtained by the "Albatross" were as follows: Simushir Island, Notojima in Isikawa Prefecture, Okinosima in Hukuoka Prefecture, and Ôsezaki in Nagasaki Prefecture. The depth of these localities were from 59 to 229 fathoms.

In the report of the Biological Survey of Mutsu Bay, two species of *Leucosolenia mutsu* HÔZAWA and *L. laxa* KIRK were dealt with by Professor HÔZAWA in 1928; the first one was described for the first time, while the remaining was identical with the previously known species.

In 1929, Professor HÔZAWA published a monograph on calcareous sponges from Japanese waters and added newly thirty-eight species tó the fauna of that group of animal. The specimens which he used came mainly from the Sagami Sea and Kiusyû District. Thus the number of calcareous sponges recorded to occur in the Japanese waters was enumerated sixty, representing seventeen genera and seven families.

During the years from 1922 to 1930, the survey of the continental shelf bordering on Japan was undertaken by the Imperial Fisheries Institute in Tokyo, and the specimens of calcareous sponges obtained thus far were forwarded to Professor HÔZAWA for identification. Using these materials, he reported in 1933 that they were represented by eight species and that the five of those eight were new to science.

In 1939, the present writer reported two new Calcarea from Saseho.

In 1940, Professor HÔZAWA recorded some calcareous sponges obtained from three different localities of Wagu in Mie Prefecture, Wajima in Isikawa Prefecture, and Ôsima in Miyagi Prefecture. In this paper he has newly established the genus *Paragrantia* which belongs to the family

Grantiidae, and also he has reported seven new species.

In the same year, the present writer recorded on the calcarea of Matusima Bay. Thus by these two papers published in 1940, fifteen more species were added to the Japanese fauna of Calcarea.

In 1941, Professor HÔZAWA and the present writer reported three species of Calcarea from Akkesi Bay, two of which were new to science.

In the same year, the present writer dealt with the calcareous sponges obtained from Mutsu Bay and Onagawa Bay, and has recorded twenty-three species, four of which were new.

In 1942, the present writer reported forty species of Calcarea from Kantô district of Japan, eleven of which were new to science. The specimens upon which his descriptions were based were collected by Professor HÔZAWA, by Professor YAICHIRO OKADA, by Dr. MEGUMI ERI, and by the present writer during the period extending from 1926 to 1940 in the same district.

Thus the fauna of the Japanese Calcarea became clearer year after year and at present the number of species of the calcareous sponges known to occur in the Japanese waters has become more than double of those shown in Professor HÔZAWA's monograph published in 1929.

It will be convenient to give here a list of literatures which contain the descriptions of the Japanese calcareous sponges.

1872. HAECKEL, E. Die Kalkschwämme.
1892. DÖDERLEIN, L. Description of *Petrostroma schulzei*, n. g. et sp. of Calcarea, representing a new Order Lithones.
1894. HARA, J. On a new Species of Calcareous Sponge, *Lelapia nipponica*. (Japanese).
1916. HÔZAWA, S. On some Japanese Calcareous Sponges belonging to the Family Heteropiidae.
1918. HÔZAWA, S. Report on the Calcareous Sponges collected by the U. S. Fisheries Steamer "Albatross" in the Northwestern Pacific during 1906.
1923. HÔZAWA, S. On a new Genus of Calcareous Sponge.
1928. HÔZAWA, S. Report of the Biological Survey of Mutsu Bay. 6. Calcarea of Mutsu Bay.
1929. HÔZAWA, S. Studies on the Calcareous Sponges of Japan.
1933. HÔZAWA, S. Report on the Calcareous Sponges obtained by the Survey of the Continental Shelf Bordering on Japan.
1939. TANITA, S. Two new Calcarea obtained from Saseho, Japan.
1940. HÔZAWA, S. On some Calcareous Sponges from Japan.
1940. TANITA, S. Calcareous Sponges of Matsushima Bay.
1941. TANITA, S. Report of the Biological Survey of Mutsu Bay. 35. Studies on the Calcarea of Mutsu Bay.
1941. HÔZAWA, S. and TANITA, S. The Fauna of Akkeshi Bay. 12. Calcarea.
1941. TANITA, S. Calcareous Sponges obtained from Onagawa Bay and its Vicinity.
1942. TANITA, S. Calcareous Sponges collected in the Kantô District, Japan.

During the period extending from 1939 to 1942, by the aid of the Scientific Research Expenditure of the Department of Education, the writer had opportunities to collect and examine the calcareous sponges of Japan, obtaining the material chiefly from Kii Peninsula, Sikoku, Kiusyû, Sanin, Hokuriku, and the Riukiu Islands. Moreover, through the courtesies of several gentlemen, he was able to have again the opportunity to examine the materials which were obtained from Palao Island and several other localities.

The writer wishes to mention here the localities where the collections have been hitherto made. In the map shown in Text-figure 1, they are numbered consecutively from north to south. The names of the localities and the number of species of the sponges obtained are shown in Table III in page 460.

The present paper deals with the results of the examination of all of the collections made in these localities mentioned above, and also deals with all of the species which were hitherto described from the Japanese waters.

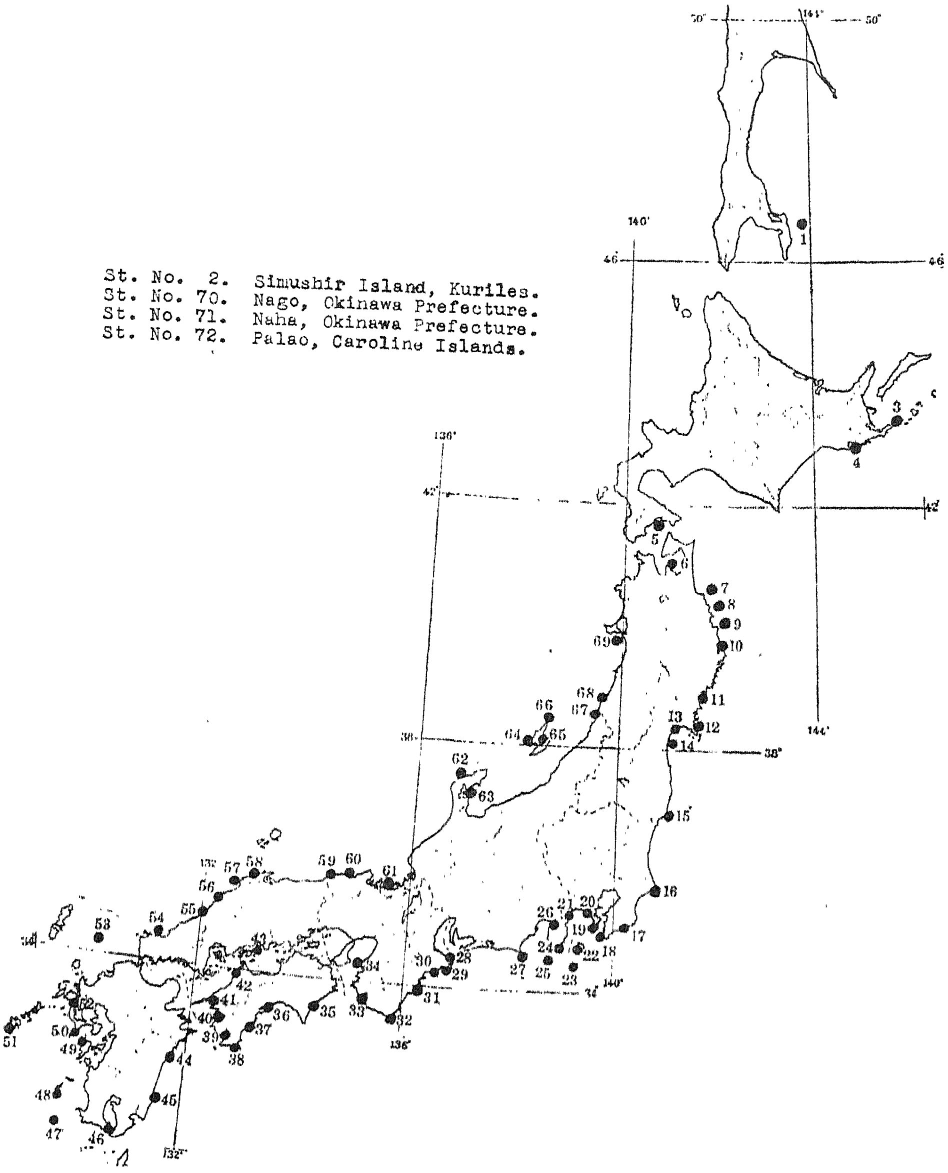
Concerning the Calcarea of the Kii Peninsula, only a single report has hitherto been made by Hôzawa. In 1940, he mentioned in his paper entitled "On some Calcareous Sponges from Japan" the following ten species, viz. *Leucosolenia clathrata* (Carter), *Leucosolenia ventosa* Hôzawa, *Leucosolenia reticulum* (O. Schmidt), *Sycetta quadriradiata* Hôzawa, *Grantessa intusarticulata* (Carter), *Paragrantia waguensis* Hôzawa, *Leucandra rigida* Hôzawa, *Leucandra spinosa* Hôzawa, *Leucandra glabra* Hôzawa and *Leucandra fragilis* Hôzawa. These species were based upon the materials obtained from Wagu, Mie Prefecture.

The writer tried a collecting trip in December, 1939, and January, 1940 to Toba, Ago Bay, and to its adjacent localities. In October of 1940, the writer collected numerous specimens along the coast of Kii Peninsula at several stations. The following is the list of the species hitherto obtained from Kii Peninsula.

Calcarea from Kii Peninsula

Family Homocoelidae

1. *Leucosolenia australis* Brφndsted
2. *Leucosolenia canariensis* (Michlucho-Maclay)
3. *Leucosolenia clathrata* (Carter)
4. *Leucosolenia coriacea* (Montagu)
5. *Leucosolenia kagoshimensis* Hôzawa



St. No. 2. Simushir Island, Kuriles.
St. No. 70. Nago, Okinawa Prefecture.
St. No. 71. Naha, Okinawa Prefecture.
St. No. 72. Palao, Caroline Islands.

Text-fig. 1.

6. *Leucosolenia laxa* KIRK
7. *Leucosolenia minuta*, n. sp.
8. *Leucosolenia mutsu* HÔZAWA
9. *Leucosolenia primordialis* (HAECKEL)
10. *Leucosolenia protogenes* (HAECKEL)
11. *Leucosolenia pyriformis*, n. sp.
12. *Leucosolenia stipitata* DENDY
13. *Leucosolenia reticulum* (O. SCHMIDT)
14. *Leucosolenia tenera* TANITA
15. *Leucosolenia ventosa* HÔZAWA
16. *Leucosolenia wilsoni* DENDY
17. *Dendya quadripodifera* HÔZAWA

Family Sycettidae

18. *Sycetta quadriradiata* HÔZAWA
19. *Sycon ciliatum* (FABRICIUS)
20. *Sycon coronatum* (ELLIS and SOLANDER)
21. *Sycon cylindricum* TANITA
22. *Sycon luteolum* TANITA
23. *Sycon matsushimense* TANITA
24. *Sycon misakiensis* HÔZAWA
25. *Sycon okadai* HÔZAWA
26. *Sycon ornatum* KIRK
27. *Sycon rotundum* TANITA

Family Heteropiidae

28. *Grantessa bifida*, n. sp.
29. *Grantessa intusarticulata* (CARTER)
30. *Grantessa mitsukurii* HÔZAWA
31. *Grantessa parva* TANITA
32. *Grantessa shimeji* HÔZAWA
33. *Grantessa shimoda* TANITA
34. *Heteropia striata* HÔZAWA
35. *Vosmaeropsis maculata* HÔZAWA

Family Grantiidae

36. *Paragrantia waguensis* HÔZAWA
37. *Leucandra abratsbo* HÔZAWA
38. *Leucandra dura* HÔZAWA
39. *Leucandra fragilis* HÔZAWA
40. *Leucandra glabra* HÔZAWA

41. *Leucandra globosa*, n. sp.
42. *Leucandra hozawai* TANITA
43. *Leucandra impigra* TANITA
44. *Leucandra multituba* HÔZAWA
45. *Leucandra rigida* HÔZAWA
46. *Leucandra spinosa* HÔZAWA
47. *Leucandra tuberculata* HÔZAWA

From the Sikoku district, no report on the calcareous sponges had been made. In 1940, however, Dr. HAYAO SATÔ made a collecting trip to Sikoku district and the specimens of the calcareous sponges which he obtained at that time were forwarded to the writer for the identification through his courtesy. In April of 1942, the writer had a chance to visit the same district and to collect some calcareous sponges. Thus, at present, the number of species of Calcarea obtained from Sikoku are fifteen in all, and they are referable to six genera belonging to four families. The following is the list of the species above aluded to.

Calcarea from Sikoku District

Family Homocoelidae

1. *Leucosolenia australis* BRØNDSTED
2. *Leucosolenia blanca* (MICHLUCHO-MACLAY)
3. *Leucosolenia cleanor* URBAN
4. *Leucosolenia protogenes* (HAECKEL)
5. *Leucosolenia stipitata* DENDY

Family Sycettidae

6. *Sycon coronatum* (ELLIS and SOLANDER)
7. *Sycon misakiensis* HÔZAWA
8. *Sycon okadai* HÔZAWA
9. *Sycon rotundum* TANITA

Family Heteropiidae

10. *Grantessa bifida*, n. sp.
11. *Grantessa mitsukurii* HÔZAWA
12. *Heteropia striata* HÔZAWA
13. *Vosmaeropsis maculata* HÔZAWA

Family Grantiidae

14. *Leucandra abratsbo* HÔZAWA
15. *Leucandra hozawai* TANITA

Until the present time, thirteen species of the calcareous sponges have been reported from Kiusyû by Professor Hôzawa (1918 and 1929) and by the present writer (1939). They are *Leucosolenia kagoshimensis* Hôzawa, *Leucaltis tenuis* Hôzawa, *Sycetta conifera* (Haeckel), *Sycetta quadriradiata* Hôzawa, *Sycon satsumensis* Hôzawa, *Sycon globulatum* Hôzawa, *Vosmaeropsis grisea* Tanita, *Grantia harai* Hôzawa, *Grantia stylata* Hôzawa, *Leucandra kagoshimensis* Hôzawa, *Leucandra tuba* Hôzawa, *Leucandra foliata* Hôzawa, and *Leucandra ohshimai* Tanita.

In April of 1940, a number of specimens of the calcareous sponges were collected by Professor Hôzawa and by the writer off Kosikijima by means of a coral collecting net. Afterwards, the writer visited the Pacific coast of Kiusyû in August of 1940 and was able to secure many specimens of Calcarea. The following is the list of the species obtained in Kiusyû chiefly by Prof. Hôzawa and by the writer during their collecting trips above-mentioned.

Calcarea from Kiusyû District

Family Homocoelidae

1. *Leucosolenia amitsbo* Hôzawa
2. *Leucosolenia coriacea* (Montagu)
3. *Leucosolenia gardineri* Dendy
4. *Leucosolenia izuensis* Tanita
5. *Leucosolenia laxa* Kirk
6. *Leucosolenia primordialis* (Haeckel)
7. *Leucosolenia protogenes* (Haeckel)
8. *Leucosolenia stipitata* Dendy
9. *Leucosolenia tenera* Tanita

Family Sycettidae

10. *Sycon coronatum* (Ellis and Solander)
11. *Sycon lendenfeldi* Row and Hôzawa
12. *Sycon luteolum* Tanita
13. *Sycon misakiensis* Hôzawa
14. *Sycon okadai* Hôzawa
15. *Sycon ornatum* Kirk
16. *Sycon pulchrum*, n. sp.
17. *Sycon rotundum* Tanita

Family Heteropiidae

18. *Grantessa mitsukurii* Hôzawa

19. *Grantessa shimoda* TANITA
20. *Heteropia striata* HÔZAWA
21. *Vosmaeropsis maculata* HÔZAWA
22. *Vosmaeropsis spinosa*, n. sp.

Family Grantiidae

23. *Ute armata* HÔZAWA
24. *Leucandra abratsbo* HÔZAWA
25. *Leucandra amakusana*, n. sp.
26. *Leucandra impigra* TANITA
27. *Leucandra mitsukurii* HÔZAWA
28. *Leucandra multituba* HÔZAWA
29. *Leucandra ohshimai* TANITA
30. *Leucandra tuberculata* HÔZAWA

As is seen from the above list, the number of species obtained from Kiusyû by the present collections is thirty in all, of which twenty-seven are those previously known, while the remaining three are new to science. Thus the fauna of Calcarea of the Kiusyû district is represented by forty-three species when there are added the thirteen species which have already been reported and accordingly are not contained in the present collections.

Our knowledge concerning the fauna of Calcarea of the Japan Sea is said to be rather scanty till the present time. In 1933, Professor HÔZAWA reported two species of *Leucosolenia soyo* and *Grantia glabra*, working out the materials collected by the survey of the continental shelf bordering on Japan. Afterwards, he made a collecting trip to Noto-Wajima and obtained five species, that is, *Leucosolenia gardineri* DENDY, *Leucosolenia laxa* KIRK, *Grantessa intusarticulata* (CARTER), *Grantessa ampullae* HÔZAWA, and *Leucandra abratsbo* HÔZAWA.

Hoping to elucidate the fauna of calcarea of the Japan Sea, the witer visited the Sanin, Hokuriku and Ôu districts in 1941 and 1942 and was able to collect a great number of specimens from various localities. The number of species obtained by the writer during the collecting trips abovementioned, are eighteen in all as shown in the following list. As is seen from the list, the number of species found in the Japan Sea is less than those obtained from the Pacific side of Honsyû. The reason of this fact is not able to make clear at present.

Calcarea from the Japan Sea

Family Homocoelidae

1. *Leucosolenia canariensis* (MICHLUCHO-MACLAY)
2. *Leucosolenia coriacea* (MONTAGU)
3. *Leucosolenia gardineri* DENDY
4. *Leucosolenia mutsu* HÔZAWA
5. *Leucosolenia laxa* KIRK
6. *Leucosolenia primordialis* (HAECKEL)
7. *Leucosolenia stipitata* DENDY

Family Sycettidae

8. *Sycon luteolum* TANITA
9. *Sycon matsushimense* TANITA
10. *Sycon misakiensis* HÔZAWA
11. *Sycon mundulum* LAMBE
12. *Sycon rotundum* TANITA

Family Heteropiidae

13. *Grantessa mitsukurii* HÔZAWA
14. *Heteropia striata* HÔZAWA
15. *Vosmaeropsis japonica* HÔZAWA
16. *Vosmaeropsis maculata* HÔZAWA

Family Grantiidae

17. *Leucandra abratsbo* HÔZAWA
18. *Leucandra impigra* TANITA

The fauna of the calcareous sponges in the Riukiu Islands and the Caroline Islands have remained entirely unknown until the present time. The writer had an opportunity to visit Okinawa in August of 1940 and was able to secure several specimens. The collection was represented by ten species, of which two are new to science, and six are common with those from other districts of Japan.

In regard to the fauna of the Caroline Islands, some specimens obtained at Palao were proposed to the writer's hands through the courtesies of several gentlemen. They were represented by six species only, but it is thought that when the survey is undertaken more thoroughly in the same district, the number of Calcarea will be greatly increased.

The following is the list of all the species of Calcarea dealt with in the present paper.

Family Homocoelidae

1. *Leucosolenia blanca* (Michlucho-Maclay)
2. *Leucosolenia clathrata* (Carter)
3. *Leucosolenia coriacea* (Montagu)
4. *Leucosolenia mutsu* Hôzawa
5. *Leucosolenia primordialis* (Haeckel)
6. *Leucosolenia protogenes* (Haeckel)
7. *Leucosolenia stipitata* Dendy
8. *Leucosolenia ventosa* Hôzawa
9. *Leucosolenia wilsoni* Dendy
10. *Leucosolenia japonica* (Haeckel)
11. *Leucosolenia kagoshimensis* Hôzawa
12. *Leucosolenia amitsbo* Hôzawa
13. *Leucosolenia canariensis* (Michlucho-Maclay)
14. *Leucasolenia depressa* Dendy
15. *Leucosolenia gardineri* Dendy
16. *Leucosolenia minuta*, n. sp.
17. *Leucosolenia serica* Tanita
18. *Leucosolenia soyo* Hôzawa
19. *Leucosolenia atlantica* Thacker
20. *Leucosolenia australis* Brøndsted
21. *Leucosolenia eleanor* Urban
22. *Leucosolenia izuensis* Tanita
23. *Leucosolenia laxa* Kirk
24. *Leucosolenia mollis* Tanita
25. *Leucosolenia pyriformis*, n. sp.
26. *Leucosolenia reticulum* (O. Schmidt)
27. *Leucosolenia sagamiana* Hôzawa
28. *Leucosolenia tenera* Tanita
29. *Dendya quadripodifera* Hôzawa
30. *Dendya triradiata*, n. sp.

Family Leucascidae

31. *Leucetta pyriformis* Dendy

Family Leucaltidae

32. *Leucaltis clathria* Haeckel
33. *Leucaltis tenuis* Hôzawa

Family Minchinellidae

34. *Petrostroma schulzei* Döderlein

Family Sycettidae

35. *Sycetta conifera* (HAECKEL)
36. *Sycetta quadriradiata* HÔZAWA
37. *Sycon album* TANITA
38. *Sycon calcar-avis* HÔZAWA
39. *Sycon ciliatum* (FABRICIUS)
40. *Sycon coronatum* (ELLIS and SOLANDER)
41. *Sycon cylindricum* TANITA
42. *Sycon digitiformis* HÔZAWA
43. *Sycon ensiferum* DENDY
44. *Sycon globulatum* HÔZAWA
45. *Sycon lendenfeldi* ROW and HÔZAWA
46. *Sycon luteolum* TANITA
47. *Sycon matsushimense* TANITA
48. *Sycon misakiensis* HÔZAWA
49. *Sycon mundulum* LAMBE
50. *Sycon okadai* HÔZAWA
51. *Sycon orantum* KIRK
52. *Sycon plumosum*, n. sp.
53. *Sycon pulchrum*, n. sp.
54. *Sycon raphanus* O. SCHMIDT
55. *Sycon rotundum* TANITA
56. *Sycon satsumensis* HÔZAWA
57. *Sycon simushirensis* HÔZAWA
58. *Sycon uragamii* TANITA
59. *Sycon yatsui* HÔZAWA

Family Heteropiidae

60. *Grantessa nemurensis* HÔZAWA
61. *Grantessa sagamiana* HÔZAWA
62. *Grantessa shimeji* HÔZAWA
63. *Grantessa shimoda* TANITA
64. *Grantessa intusarticulata* (CARTER)
65. *Grantessa mitsukurii* HÔZAWA
66. *Grantessa bifida*, n. sp.
67. *Grantessa ampullae* HÔZAWA
68. *Grantessa basipapillata* HÔZAWA
69. *Grantessa parva* TANITA
70. *Heteropia medioarticulata* HÔZAWA
71. *Heteropia striata* HÔZAWA

72. *Amphiute ijimai* HÔZAWA
73. *Vosmaeropsis japonica* HÔZAWA
74. *Vosmaeropsis grisea* TANITA
75. *Vosmaeropsis spinosa*, n. sp.
76. *Vosmaeropsis maculata* HÔZAWA
77. *Vosmaeropsis sasakii* HÔZAWA

Family Grantiidae

78. *Grantia harai* HÔZAWA
79. *Grantia kujiensis* HÔZAWA
80. *Grantia nipponica* HÔZAWA
81. *Grantia uchidai* HÔZAWA and TANITA
82. *Grantia cupla* (HAECKEL)
83. *Grantia glabra* HÔZAWA
84. *Grantia stylata* HÔZAWA
85. *Paragrantia waguensis* HÔZAWA
86. *Ute armata* HÔZAWA
87. *Ute pedunculata* HÔZAWA
88. *Achramorpha diomediae* HÔZAWA
89. *Anamixilla torresi* POLÉJAEFF
90. *Leucandra hozawai* TANITA
91. *Leucandra kagoshimensis* HÔZAWA
92. *Leucandra kurilensis* HÔZAWA
93. *Leucandra magna* TANITA
94. *Leucandra odawarensis* HÔZAWA
95. *Leucandra tomentosa* TANITA
96. *Leucandra tropica*, n. sp.
97. *Leucandra valida* LAMBE
98. *Leucandra vermiformis* TANITA
99. *Leucandra abratsbo* HÔZAWA
100. *Leucandra globosa*, n. sp.
101. *Leucandra impigra* TANITA
102. *Leucandra mediocanellata* HÔZAWA
103. *Leucandra mitsukurii* HÔZAWA
104. *Leucandra multituba* HÔZAWA
105. *Leucandra nakamurai* TANITA
106. *Leucandra paucispina* HÔZAWA
107. *Leucandra rigida* HÔZAWA
108. *Leucandra sagamiana* HÔZAWA
109. *Leucandra sola* TANITA

110. *Leucandra solida* HÔZAWA
111. *Leucandra spinosa* HÔZAWA
112. *Leucandra cerebrum* HÔZAWA and TANITA
113. *Leucandra dura* HÔZAWA
114. *Leucandra foliata* HÔZAWA
115. *Leucandra fragilis* HÔZAWA
116. *Leucandra ohshimai* TANITA
117. *Leucandra onigaseana* HÔZAWA
118. *Leucandra pacifica* HÔZAWA
119. *Leucandra tuba* HÔZAWA
120. *Leucandra tuberculata* HÔZAWA
121. *Leucandra yuriagensis* HÔZAWA
122. *Leucandra amakusana*, n. sp.
123. *Leucandra consolida*, n. sp.
124. *Leucandra glabra* HÔZAWA
125. *Leucandra okinoseana* HÔZAWA
126. *Leucandra palaoensis*, n. sp.
127. *Leucopsila stylifera* (O. SCHMIDT)
128. *Leucyssa spongilla* HAECKEL

Family Amphoriscidae
129. *Leucilla hirsuta* TANITA
130. *Leucilla minuta* TANITA

Family Lelapiidae
131 *Lelapia nipponica* HARA

The number of species treated in the present paper is 131 in all and they belong to 21 genera and 9 families. Of these 131 species, 12 are new to science and 10 are reported for the first time from the Japanese waters. Most of the specimens which were collected by Professor HÔZAWA, by Dr. SATÔ, and by the present writer, and were used in the present study, are now deposited in the Museum of the Biological Institute of the Tôhoku Imperial University.

Before proceeding further, the writer returns his hearty thanks to Professor Dr. SANJI HÔZAWA of the Tôhoku Imperial University for the kind guidance and valuable advice rendered him during the course of the present investigation. Further the writer wishes to express his thanks to Assistant Professor Dr. HAYAO SATÔ of the same University, to Dr. NOBORU ABE of the Kiturin Higher Normal School, to Mr. GENJI KATÔ of the Palao Tropical Biological Station, and to Mr. GORÔ TADA of the Mie

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II. DESCRIPTION OF THE SPECIES

A. Family **Homocoelidae** DENDY

Diagnosis:—The whole of the gastral cavity and its various outgrowths lined by collared cells throughout the life of the sponge. Sponge colony rarely radiate, and, if so, the central individual retains the primitive ascon structure, with a lining of collared cells and without a special gastral cortex. No true dermal membrane or true dermal cortex is ever developed.

Genus **Leucosolenia** BOWERBANK (1864–1882)

Diagnosis:—Diverticula of the gastral cavity, if any, never radially arranged around a central tube. Skeleton composed of triradiate or quadriradiate spicules, to which oxea may be added. No uteoid dermal skeleton. Nucleus of collared cells basal or apical.

1. **Leucosolenia blanca** (MICHLUCHO-MACLAY)

(Pl. XI, fig. 1)

Guancha blanca, MICHLUCHO-MACLAY, 1868, p. 221, Pls. 4, 5; HAECKEL, 1870, p. 254.
Olynthus guancha, HAECKEL, 1870, p. 237.
Leucosolenia guancha, HAECKEL, 1870, p. 243.
Tarrus guancha, HAECKEL, 1870, p. 244.
Nardoa guancha, HAECKEL, 1870, p. 247.
Ascetta blanca, HAECKEL, 1872, p. 38, Pl. 5, fig. 5; LENDENFELD, 1891, p. 218, Pl. 8, fig. 5; ARNESEN, 1900, p. 9.
Leucosolenia blanca, POLÉJAEFF, 1883, p. 37, Pl. 1, fig. 2, Pl. 3, fig. 3; LACKSCHEWITZ, 1886, p. 300; VOSMAER, 1887, p. 370; BREITFUSS, 1896, p. 1; 1897, p. 210; 1898, p. 13; p. 19; p. 105; 1932, p. 240; 1935, p. 7; 1936, p. 5; DENDY and ROW, 1913, p. 724; ARNDT, 1928, p. 19, figs. 9, 10; BRØNDSTED, 1928, p. 12, text-figs. 7, 8; HÔZAWA, 1929, p. 282; TOPSENT, 1936, p. 9, figs. 4, 5; TANITA, 1942, p. 75.
Clathrina blanca, MINCHIN, 1896, p. 359; JENKIN, 1908, p. 438, figs. 85–87.

This widely distributed species is represented by two specimens in the collection. They were obtained by Dr. HAYAO SATÔ from two different localities of Usa and Mimase in Kôti Prefecture.

The specimen which came from Usa (Pl. XI, fig. 1) was collected from the pearl-oyster bed and it is formed in a flat fan-shaped head perched at the tip of a stalk. It consists of a mass of anastomosing tubes. The sponge is 10 mm high, 6.5 mm broad, and 3 mm thick. The colour in alcohol is white and the texture is soft.

The other specimen was secured from a wire used in fishing at Mimase and is closely similar in appearance to the first specimen above-mentioned. It measures 8 mm in height, 5 mm in breadth and 1.3 mm in thickness. The colour of the specimen is dirty white in the preserved state.

Previously known Distribution:—Cosmopolitan. Kara Sea; Murman Coast; White Sea; East Spitzbergen; Azores Islands; Pico Fayal; Brazil; Naples; Minorca; Lesina; Kiel Bay; Philippine Islands; Sagami Sea.

Localities:—Usa and Mimase in Kôti Prefecture.

2. **Leucosolenia clathrata** (CARTER)

Leucetta clathrata, CARTER, 1883, p. 33, Pl. 1, figs. 13–17.
Clathrina tripodifera var. *gravida*, CARTER, 1886, p. 507.
Leucosolenia tripodifera var. *gravid*, DENDY, 1891, p. 68.
Leucosolenia intermedia, KIRK, 1895, p. 208, Pl. 4, fig. 2; BRØNDSTED, 1926, p. 298.
Leucosolenia clathrata, DENDY and ROW, 1913, p. 724; ROW and HÔZAWA, 1931, p. 730; HÔZAWA, 1940, p. 30; TANITA, 1942, p. 76.

Distribution:—S. W. coast of Australia (CARTER); Near Port Phillip Heads, Westernport, Kent Islands (DENDY); Cook Strait (KIRK); Island Bay, Wellington (BRØNDSTED); Gelaldton District, Frementle Bay, Bunbury Bay (ROW and HÔZAWA); Wagu in Mie Prefecture (HÔZAWA).

Remarks:—Judging from the localities mentioned above, this species seems to be very common in Australia and New Zealand. From the adjacent seas of Japan, it has been recorded by HÔZAWA from Wagu, but there is no specimen contained in the present collection.

3. **Leucosolenia coriacea** (MONTAGU)

(Pl. XI, fig. 2)

Spongia coriacea, MONTAGU, 1812, p. 116.
Grantia coriacea, JOHNSTON, 1842, p. 183, Pl. 21, fig. 9.
Leucosolenia coriacea, BOWERBANK, 1866, p. 34; GRAY, 1867, p. 556; CARTER, 1877, p. 42; HANITSCH, 1895, p. 206; BREITFUSS, 1897, p. 211; 1898, p. 12; p. 20; p. 91; 1927, p. 28; 1932, p. 241; 1935, p. 7; 1936, p. 6; DENDY, 1905, p. 226, Pl. 13, fig. 8; LUNDBECK, 1909, p. 457; ROW, 1909, p. 184; DENDY and ROW,

1913, p. 725; HERNANDEZ, 1918, p. 9; BURTON, 1926, p. 71; 1929, p. 402; 1930, p. 2; 1933, p. 235; ARNDT, 1928, p. 18, fig. 6; ROW and HÔZAWA, 1931, p. 735; BURTON and RAO, 1932, p. 303; TOPSENT, 1936, p. 2, figs. 1, 2: TANITA, 1942, p. 20; p. 74.

Clathrina sulphurea, CARTER, 1871, p. 279.

Clathrina coriacea, RIDLEY, 1881, p. 132; MINCHIN. 1896, p. 359; JENKIN, 1908, p. 6.

Ascetta coriacea, HAECKEL, 1872, p. 24, Pls. 3, 5, fig. 2; FRISTEDT, 1887, p. 405, Pl. 22, figs. 1, 2; HANITSCH, 1890, p. 232; ARNESEN, 1900, p. 10.

This well-known species is represented in the collection by many specimens obtained from eight different localities.

Each of the specimens shows a more or less flattened loose mass, composed of branching and anastomosing Ascon-tubes, attached to the sea-weed or to other foreign object by its lower part. The largest specimen attains 15 mm in length and 10 mm in breadth. Most of the specimens have a greyish tint in colour but several of them are nearly white. The texture is rather soft.

Previously known Distribution:—Cosmopolitan: Arctic Ocean; Atlantic Coast of Europe; Mediterranean Sea; Pacific Ocean; Indian Ocean; West Australia. *In Japan*—Bosyû Sunosaki; Misaki (TANITA).

Localities:—Toba Bay; Kii-Nagasima; Tanabe Bay; Hiuga Utimi; Mogi Bay, near Nagasaki; Izumo-Kagamura; Wakasa-Takahama; Naha, Okinawa Prefecture.

Remarks:—This species was described for the first time by MONTAGU in 1812 under the name of *Spongia coriacea.* Afterwards, it has been reported by many investigators from various parts of the world.

In 1942, the writer reported this species as found in the adjacent sea of Kantô District. The writer stated in the same report that the present species will be discovered in various parts along the coast of Japan in the future. Judging from the fact mentioned by the present collections, the species in question is considered to be met with often in the waters of Japan.

4. **Leucosolenia mutsu** HÔZAWA

Leucosolenia mutsu, HÔZAWA, 1928, pp. 219–220, Pl. 1, figs. 1–3; 1940, p. 35; TANITA, 1940, p. 165, Pl. 8, fig. 1; 1941, p. 267; 1942, p. 23, Pl. 2, fig. 2; p. 73.

Numerous specimens of this species exist in the collection. They were collected by the writer from five different localities.

Each of them is a small irregular mass, consisting of a loose net-work of Ascon-tubes.

The colour varies from nearly white to grey in the preserved state.

This species was fully described by HÔZAWA (1928) so that no further details are necessary.

Previously known Distribution:— Mutu Bay; Kesennuma Bay (HÔZAWA); Matusima Bay; Onagawa Bay; Simoda; Kamakura; Misaki; Awa-Kominato; Sunosaki; Tateyama (TANITA).

Localities:— Sionomisaki and Kata, Wakayama Prefecture; Kagamura and Esumi, Simane Prefecture; Wakasa-Takahama.

Remarks:— This species was first established by HÔZAWA in 1928, and since then has been reported by HÔZAWA and the writer several times as found in several localities. This form, therefore, seems to be found rather common along the coast of Japan, being obtained at many localities as mentioned above.

5. **Leucosolenia primordialis** (HAECKEL)

(Pl. XI, fig. 3)

Prosycum primordiale, HAECKEL, 1870, p. 237.
Olynthus simplex, HAECKEL, 1870, p. 237.
Ascetta primordialis, HAECKEL, 1872, p. 16, Pls. 1, 2, Pl. 5, fig. 1; LENDENFELD, 1885, p. 897; 1891, p. 195, Pl. 8, fig. 1, Pl. 9, figs. 23 26; ARNESEN, 1900, p. 12.
Clathrina primordialis, CARTER, 1886. p. 510; MINCHIN, 1896, p. 359; JENKIN, 1908, p. 6; 1908, p. 436; ROW, 1909, p. 184.
Leucosolenia primordialis, LACHSCHEWITZ. 1886, p. 299; BREITFUSS, 1897, p. 212; 1898, p. 12; p. 21; p. 91; 1932, p. 242; 1935, p. 12; DENDY and ROW, 1913, p. 726; HERNANDEZ, 1918, p. 10; BURTON. 1926, p. 71; BRØNDSTED, 1928, p. 9, text-fig. 1; ROW and HÔZAWA, 1931, p. 736; TANITA, 1942, p. 73.

Many specimens of this well-known species exist in the collection which were collected from six different localities.

The specimen which was obtained from the pearl oyster bed in Tanabe Bay (Pl. XI, fig. 3) is a strongly flattened colony and is attached by the lower surface to the foreign object. It is composed of irregularly anastomosing and branching Ascon-tubes of about 0.5 mm in diameter.

The remaining specimens are usual clathrous colonies.

The colour of the specimens in alchohol vary from nearly white to yellowish white.

Previously known Distribution:— Cosmopolitan: Mediterranean Sea; Atlantic Ocean; Red Sea; Indian Ocean; Coast of Australia.

Localities:— Tanabe Bay; Hiuga-Aosima; Amakusa-Tomioka; Mogi Bay, near Nagasaki; Tuiyama Bay, Hyôgo Prefecture; Naha, Okinawa Prefecture.

Remarks:— This species is cosmopolitan, having been widely distributed and obtained from many localities in the world as mentioned above. It has not been, however, hitherto obtained from the adjacent seas of Japan before the present collection.

Judging from the distribution in Japan, the present species seems to be rather common in the southern parts of Japan.

6. **Leucosolenia protogenes** (HAECKEL)

(Pl. XI, fig. 4)

Ascetta primordialis var. *protogenes*, HAECKEL, 1872, p. 16, Pls. 1, 2, Pl. 5, fig. 1.
Ascetta procumbens, LENDENFELD, 1885, p. 1086.
Clathrina primordialis, CARTER, 1886, p. 510.
Leucosolenia protogenes, DENDY, 1891, p. 58, Pl. 3, fig. 1, Pl. 11, fig 1; BREITFUSS, 1897, p. 213; 1932, p. 243; 1935, p. 13; DENDY and ROW, 1913, p 726; DENDY and FREDERICK, 1924, p. 480, Pl. 25, fig. 2; BRØNDSTED, 1926, p. 297; TANITA, 1942, p. 24, Pl. 2, fig. 3; p. 73.

This species is represented by numerous specimens in the collection which were collected from the various lacalities of Kii Peninsula, Sikoku, and Kiusyû. They vary a good deal both in shape and in size.

The largest specimen (Pl. XI, fig. 4) which was deposited in the Museum of the Seto Marine Biological Station, forms a large irregular massive colony consisting of anastomosing Ascon-tubes. The colony attains about 25 mm in height and 40 mm in breadth and is attached with the lower surface to the substratum. The diameter of the Ascon-tubes varies from 0.3 mm to 1.2 mm according to their position in the colony. The colour of the specimen is nearly white and the texture is rather soft and spongy.

The specimens which were obtained from the pearl oyster bed in Tanabe Bay, Ago Bay, and Usa, are softer in texture than that of the specimen mentioned-above, being composed of a loose network of thicker Ascon-tubes. The colour is dirty grey due to the contamination with mud.

The remaining specimens which came from the various localities in Sikoku and Kiusyû are smaller and more irregular in shape than the above-mentioned.

With respect to the canal system, structure, and spicules, all these specimens are identical with each other, and agree well with the description of this species given by the previous writers such as HAECKEL, DENDY, and LENDENFELD.

Previously known Distribution:— Cosmopolitan: South and East Coasts of Australia (HAECKEL, DENDY, LENDENFELD); West Coast of Australia (DENDY and FREDERICK); Campbell and Auckland Island (BRØNDSTED); New

Zealand (BRØNDSTED). *In Japan* — Bosyû Tateyama (TANITA).

Localities:— Kii Peninsula: Toba Bay, Momotori-mura, Ago Bay, Hamajima, Tanabe Bay; Sikoku district: Mimase, Usa, Sukumo-Ôsima in Kôti Pref.; Hirayama, Uwajima, Yahatahama, Takahama in Ehime Pref.; Kiusyû district: Tomioka, Province of Amakusa.

Remarks:— This species was first described by HAECKEL in 1872 as a varity of *Leucosolenia primordialis* under the name of *Ascetta primordialis* var. *protogenes*.

In 1891, DENDY reported this species from Australia and he discussed in the same report that *Ascetta procumbens* and *Clathrina primordialis* which were named by LENDENFELD and by CARTER respectively, are synonymous with the present species. Since that time, it has been recorded by several investigators as found in various parts of the world.

In 1942, this cosmopolitan species was reported by the present writer as found in Japan. This was the second case of this species, being recorded as having been found in the Japanese waters, and thus, the present form is also considered to be common in the southern parts of Japan.

7. Leucosolenia stipitata DENDY

(Pl. XI, figs. 5–7)

Leucosolenia stipitata, DENDY, 1891, pp. 51–52, Pl. 1, figs. 4–6, Pl. 4, fig. 2, Pl. 9, fig. 5; DENDY and ROW, 1913, p. 727; ROW and HÔZAWA, 1931, p. 739; TANITA, 1942, p. 26, Pl. 2, fig. 5; p. 75.

Many specimens of this species were collected by the writer himself at the various localities shown in the Table I.

The specimens vary from club-shape to nearly cylindrical in shape as shown in Pl. XI, figs. 5–7. Each of the specimens consists of a more or less oval body and of a stem by which the sponge is attached to the substratum. The body has the reticulate surface and is provided usually with a relatively large osculum on its summit.

Dendy has stated in his original description as follows: "This is a very minute sponge, ... Only one osculum is present in the specimens figured, but I should imagine that there might sometimes be more in older specimens."

The specimens at the writer's hand are all very small, the total length of them varying from 1.5 mm to 10 mm as shown in the Table I. The largest specimen (Pl. XI, fig. 5) which came from Takahama is provided with two oscula.

TABLE I. The localities and numbers of specimens obtained

Localities	No. of specimens obtained	Total length in mm.	Date
Momotori-mura, Mie Pref.	6	3.0-7.0	Dec. 30, '39
Hamajima, Ditto.	2	3.0-6.5	Jan. 1, '40
Owasi, Ditto.	4	2.3-3.5	Oct. 9, '39
Kata, Wakayama Pref.	3	2.5-3.0	Oct. 14, '39
Takahama, Ehime Pref.	4	3.0-10.0	April 3, '42
Hosojima, Miyazaki Pref.	5	2.0-5.3	July 16, '40
Aosima, Ditto.	2	4.0	July 15, '40
Tomioka, Kumamoto Pref.	3	2.5-3.8	Mar. 27, '40
Mogi, Nagasaki Pref.	3	2.3-6.5	Mar. 25, '40
Hamada, Simane Pref.	2	3.0	July 8, '41
Kaga-mura, Ditto.	2	2.0-4.0	July 6, '41
Hamasaka, Hyôgo Pref.	1	4.0	July 4, '41
Tuiyama-wan, Ditto.	5	1.8-3.0	Oct. 17, '40
Wakasa-Takahama, Hukui Pref.	8	1.5-7.0	Oct. 15, '40
Sado-Aikawa, Niigata Pref.	1	3.0	July 19, '41
Naha, Okinawa Pref.	1	7.5	June 6, '40

The colour of the sponge in the preserved state varies from white to grey ; the grey tint will due to the contamination with mud.

With regard to the canal system, the arrangement of the skeleton and other details, the present specimens are identical with the original description of this species given by DENDY.

Previously known Distribution:—Port Phillip Heads (DENDY); Geraldton District (ROW and HÔZAWA). *In Japan*—Sunosaki and Awa-Kominato (TANITA).

Localities:—See Table I.

Remarks:—This species was described for the first time by DENDY in 1891, using two specimens obtained from Port Phillip Heads. Afterwards, it was reported by ROW and HÔZAWA from Geraldton District, S. W. Australia. From the Japanese waters, this species was reported by the present writer in 1942.

Of the present collections, the specimens of this species were obtained in great number from various localities shown in the Table I. Thus the present species seems to be one of the species widely distributed along the coasts of Japan proper.

Although this species may be easily distinguished from other members of the genus *Leucosolenia* by the special external features and by the spicules, it is very small in form. However, when the more careful survey are undertaken, this form may become to be considered cosmopolitan.

8. Leucosolenia ventosa Hôzawa

Leucosolenia ventosa, Hôzawa, 1940, pp. 31–32, Pl. 4, fig. 1, text-fig. 1; Tanita, 1942, p. 75.

Locality:— Wagu, Mie Prefecture (Hôzawa).

9. Leucosolenia wilsoni Dendy

(Pl. XI, fig. 8)

Leucosolenia wilsoni, Dendy, 1891, pp. 63–65, Pl. 2, figs. 3, 4, Pl. 7, Pl. 11, fig. 3; Dendy and Row, 1913, p. 727; Tanita, 1942, p. 27; p. 73.

This species is represented by a single specimen in the collection which was obtained by the writer himself from the pearl oyster bed of Momotori-mura, Mie Prefecture. The sponge forms a flattened, spreading mass, consisting of branching and anastomosing Ascon-tubes.

The colour in the preserved state is dirty yellow.

Previously known Distribution:— Near Port Phillip Heads (Dendy); *In Japan* — Misaki (Tanita).

Locality:— Momotori-mura, Mie Prefecture.

Remarks:— This species was first described by Dendy in 1891. The present writer has reported on the occurrence of this species at Misaki and this is, therefore, the second report of this form from the Japanese waters.

10. Leucosolenia japonica (Haeckel)

Ascilla japonica. Haeckel, 1872, p. 47, Pl. 6, figs. 8, 9.

Leucosolenia japonica, Dendy and Row, 1913, p. 726; Hôzawa, 1929, p. 285; Tanita, 1942, p. 77.

Locality:— Tôkyô Bay (Haeckel).

Remarks:— This species was first described by Haeckel in 1872 in his monograph on the calcareous sponges under the name of *Ascilla japonica* but it has not been reported from Japanese waters since.

11. Leucosolenia kagoshimensis Hôzawa

(Pl. XI, fig. 9)

Leucosolenia kagoshimensis, Hôzawa, 1929, pp. 285–286, Pl. 1, figs. 6, 7, text-fig. 3; Tanita, 1942, p. 77.

Only a single specimen (Pl. XI, fig. 9) which exists in the collection was assigned to this species. It was collected by means of a coral-dredge off Hayata-ura in Mie Prefecture from a depth of 70–90 fathoms.

The sponge is a solitary individual in the form of strongly compressed thin-walled tube. It is 10 mm high and 2.5 mm broad in the broadest part. The oscular portion is damaged. The dermal surface is nearly smooth and the colour in alcohol is greyish yellow.

The skeleton of the sponge is composed of sagittal quadriradiates only which are arranged in a single or two layers in the body wall. The dimensions of the spicules appear to be slightly larger than those of the type, but in other details the present specimen seems to agree well with the type.

Previously known Distribution :— Kagosima Bay (Hôzawa).

Locality :— Off Hayata-ura in Mie Prefecture, 70–90 fathoms.

Remarks :— This is the second record dealing with the present species taken from Japanese waters. This species seems to be found in deep sea only, though the depth of the locality where the collecting the type specimen was made, was not mentioned in the original description.

12. **Leucosolenia amitsbo** Hôzawa

(Pl. XI, fig. 10)

Leucosolenia amitsbo, Hôzawa, 1929, pp. 283–285, Pl. 1, figs. 3–5, text-fig. 2; Tanita, 1942, p. 79.

This species is represented by four specimens in the collection. They were collected by means of a coral-dredge off Kosikijima in Kagosima Prefecture from a depth of about 100 fathoms.

The first specimen (Pl. XI, fig. 10) is irregularly ovoid in shape and is strongly laterally compressed. It measures 17 mm in length and 13 mm in breadth. The pseudosculum at the top of the body is very small and is nearly circular in shape with a diameter of 1 mm. The pseudopores are variable in shape from circular to oval and are distributed all over the pseudoderm. The colour in alcohol is dirty white.

The second and third specimens are closely similar in appearance. Each of them represents a solitary person of a slightly laterally compressed tubular form, attached by a base to foreign object and showing at the upper end a pseudosculum of nearly circular shape.

The remaining one is a fragment from the basal parts, being the upper half torn off.

With respect to the canal system, spiculations, and etc., this species has been fully described by Hôzawa (1929), so that the writer does not feel the necessity to add further details to it.

Previously known Distribution:— Sagami Sea, depth of 50–400 fathoms (Hôzawa).

Locality:— Off Kosikijima in Kagosima Prefecture, depth of 100 fathoms.

Remarks:— This species was first described by Hôzawa, using the specimens obtained from the Sagami Sea. This is, therefore, the second record of this form. Judging from the depth of the localities abovementioned, this species seems to be found only in the deep sea.

13. **Leucosolenia canariensis** (Michlucho-Maclay)

(Pl. XII, figs. 11, 12)

Nardoa canariensis, Michlucho-Maclay, 1868, p. 230.
Nardoa sulphurea, Michlucho-Maclay, 1868, p. 230.
Nardoa rubra, Michlucho-Maclay, 1868, p. 230.
Torroma canariensis, Haeckel, 1870, p. 244.
Torroma rubrum, Haeckel, 1870, p. 245.
Ascaltis canariensis, Haeckel, 1872, p. 52, Pl. 9, figs. 1–3, Pl. 10, fig. 1.
Ascaltis compacta, Schuffner, 1877, p. 404, Pl. 25, fig. 9.
Leucosolenia nanseni, Breitfuss, 1896, p. 427; 1898, p. 13; p. 106, Pl. 12, figs. 1-9; 1932, p. 242; Lundbeck, 1909, p. 458.
Leucosolenia canariensis, Lackschewitz, 1886, p. 300, Pl. 7, fig. 1; Thacker, 1908, p. 762, Pl. 40, fig. 3, text-figs. 157–160; Dendy and Row, 1913, p. 724; Hôzawa, 1918, p. 528; 1933, p. 2, Pl. 1, fig. 1; 1940, p. 134, Pl. 6, fig. 2, text-fig. 2; Breitfuss, 1932, p. 240; Tanita, 1941, p. 264, Pl. 17, fig. 1; 1942, p. 77.

Numerous specimens of this well-known species were collected from seven different localities. They vary both in shape and size considerably.

Each of the specimens forms an irregularly shaped massive colony, composed of net-work of branching and anastomosing Ascon-tubes. The largest specimen which was obtained from the pearl oyster bed in Ago Bay measures 40 mm in height and 24 mm in the greatest breadth.

The colour of the specimens vary from nearly white to dirty grey.

As these specimens are identical to the type with regard to the structure and the spiculation, there is no need to add further descriptions.

Previously known Distribution:— Canary Islands (Michlucho-Maclay); Cape Verde Islands (Thacker); Mauritus (Schuffner); Minorca (Lackschewitz); Spitzbergen; Arctic Ocean (Breitfuss); off Copper Island, Commander Island; Mexico (Hôzawa). *In Japan* — Off Yuriage, Miyagi Prefecture (Hôzawa); Onagawa Bay (Tanita).

Localities:— Ago Bay and Owasi, Mie Pref.; Senzaki, Yamaguti Pref.; Tuiyama Bay, Hyôgo Pref.; Wakasa-Takahama; Naha, Okinawa Pref.; Palao.

Remarks:— This species was previously reported by Hôzawa (1933) and by the writer (1941) from the Japanese waters. From the waters of foreign countries it has been obtained in many localities by several collectors. Thus this species may be considered to be cosmopolitan.

14. **Leucosolenia depressa** Dendy

(Pl. XII, fig. 13)

Leucosolenia depressa, Dendy, 1891, pp. 65–66, Pl. 3, fig. 4, Pl. 8, fig. 8, Pl. 11, fig. 4; Kirk, 1895, p. 209; Dendy and Row, 1913, p. 725; Tanita, 1942, p. 78.

Four specimens contained in the collection agree so closely with the description of *Leucosolenia depressa* given by Dendy and thus the writer has no hesitation in making a specific identification. They were obtained by the writer from the sea-shore of Naha, Okinawa Prefecture. All of them have nearly the similar appearance, and one of them is shown in Pl. XII, fig. 13.

Each of them forms a flattened, spreading, irregular crust, attached to some dead corals at a few points. The largest specimen measures 10 mm in length and 7 mm in breadth. Several conical papillae are scattered on the upper surface, each of which with a small osculum at its summit. The colour of the specimens in alcohol is yellowish grey.

The skeleton consists of numerous regular quadriradiates and of regular triradiates of two kinds, larger and smaller. The larger triradiates are found only in the pseudodermal membrane.

The canal system and other minute structures of this species have been fully described by Dendy so that no further details are necessary.

Previously known Distribution:— Near Port Phillip Heads (Dendy).

Locality:— Naha in Okinawa Prefecture, sublittoral.

Remarks:— This is the second report dealing with the occurrence of this species in the world.

15. **Leucosolenia gardineri** Dendy

(Pl. XII, fig. 14)

Leucosolenia gardineri, Dendy, 1913, pp. 2–6, Pl. 1, figs. 1, 2, Pl. 3, figs. 1–3; Dendy and Row, 1913, p. 725; Hôzawa, 1940, p. 35; Tanita, 1942, p. 78.

Numerous specimens of this species were collected by the writer from five different localities. They vary a good deal both in shape and size. Each of the specimens is consisted of very slender Ascon-tubes, forming a very closely meshed reticulation. The surface of the sponge is perforated by numerous pseudopores.

The largest specimen (Pl. XII, fig. 14) from Amakusa is an irregulary flattened colony of Ascon-tubes, attached to the substratum directly, and is 32 mm in breadth.

The colour in alcohol is pure white or nearly so with faint yellowish tint.

Previously known Distribution:— Chagos Archipelago (DENDY). *In Japan* — Wajima, Isikawa Prefecture (HÔZAWA).

Localities:— Amakusa-Tomioka; Mogi, near Nagasaki; Izumo-Kagamura; Hamasaka, Hyôgo Pref.: Wakasa-Takahama.

Remarks:— About the occurrence of this species from the Japanese waters, HÔZAWA already reported in 1940 from Noto-Wajima. This is the second record of this form from the seas of Japan.

16. **Leucosolenia minuta**, n. sp.

(Pl. XII, fig. 15; Text-figs. 2, 3)

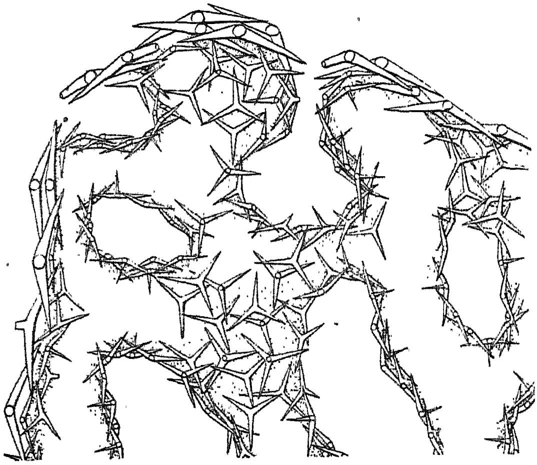
This new species is based upon two specimens found in the collection. They were obtained by the writer himself from the shore of Sionomisaki.

Each of them represents a nearly oval form, consisting of anastomosing Ascon-tubes, and is more or less laterally compressed with a stalk-like protuberance with which the sponge attaches to the substratum. The total length is only 3.3 mm and the greatest breadth is 2 mm. At the upper end of the body, there exhibits a minute osculum. The pseudopores are nearly uniformly distributed all over the pseudoderm.

The colour in alcohol is white and the texture is rather soft.

Structure (Text-fig. 2): —The canal system seems to belong to DENDY's reticulate type B[1].

The skeleton is composed of triradiates and quadriradiates. The pseudoderm consists of larger



Text-fig. 2. *Leucosolenia minuta*, n. sp. Part of a cross-section; ×90.

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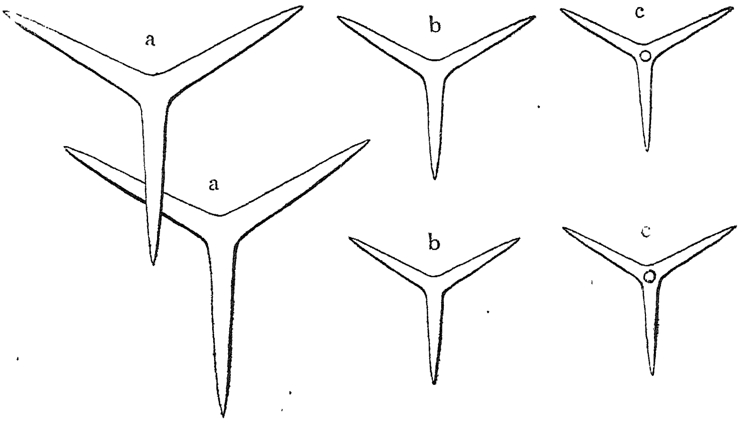
[1] DENDY, A. Trans. Roy. Soc. Victoria, Vol. 3, 1891, p. 27.

triradiates, which are arranged in a few layers leaving angular pseudopores. The walls of Ascon-tubes are made up of an admixture of smaller triradiates and quadriradiates, though the former kind of spicules are more numerous than the latter. They are arranged in a thin confused layer and the apical rays of quadriradiates project into the gastral cavity.

Spicules (Text-fig. 3):—Large triradiates of pseudoderm (a) regular. Rays stout, straight, tapering to sharp point, 130–175 μ long and 14–18 μ thick at base.



Text-fig. 3. *Leucosolenia minuta*, n. sp. a, large triradiates of pseudoderm; b, small triradiates of Ascon-tube; c, quadriradiates of Ascon-tube. All × 240.

Smaller triradiates of Ascon-tubes (b) also regular and like the larger ones above-mentioned in shape, but rays are shorter and thinner, measuring 60–75 μ in length and 8–10 μ in thickness at base.

Quadriradiates of the same (c) similar to smaller triradiates, differing only in the presence of apical ray. Apical ray nearly straight, sharply pointed, slightly shorter than facial rays, 50–60 μ long and 7–10 μ thick at base.

Locality:— Sionomisaki, Wakayama Prefecture.

Remarks:— This species appears to resemble closely *Leucosolenia stipitata* DENDY(1) in external features and canal system, while in spiculation it approaches to *L. soyo* HÔZAWA(2) and *L. gardineri* DENDY(3). *L. stipitata*, however, differs from this species in the shape of spicules. The present species may be easily distinguished from *L. soyo* and *L. gardineri* by the dimensions of spicules, by the canal system, and by the external appearance.

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(1) *Leucosolenia stipitata*, DENDY, 1891, pp. 51–52, Pl. 1, figs. 4–6, Pl. 4, fig. 2, Pl. 9, fig. 5.

(2) *Leucosolenia soyo*, HÔZAWA, 1933, pp. 4–7, Pl. 1, fig. 2, text-fig. 1.

(3) *Leucosolenia gardineri*, DENDY, 1913, pp. 2–6, Pl. 1, figs. 1, 2, Pl. 3, figs. 1–3.

17. Leucosolenia serica TANITA

Leucosolenia serica, TANITA, 1942, pp. 25-26, Pl. 2, fig. 4, text-fig. 2; p. 78.

Locality:— Yodomi in Sagami Sea, 100–200 fathoms (TANITA).

Remarks:— This species was established by the present writer in 1942, basing the description upon three specimens secured by Dr. ERI from Yodomi in Sagami Sea. This species seems to be found only in the deep sea.

18. Leucosolenia soyo HÔZAWA

Leucosolenia soyo, HÔZAWA, 1933, pp. 4–7, Pl. 1, fig. 2, text-fig. 1; TANITA, 1942, p. 78.

Distribution:— Off Hudai, Rikutyû, 170 meters; near Sado Island, 168 meters (HÔZAWA).

Remarks:— This species seems to be found only in the deep sea.

19. Leucosolenia atlantica THACKER

(Pl. XII, fig. 16; Text-fig. 4)

Leucosolenia atlantica, THACKER, 1908, pp. 760–761, Pl. 40, fig. 2, text-fig. 156; DENDY and ROW, 1913, p. 721; TANITA, 1942, p. 81.

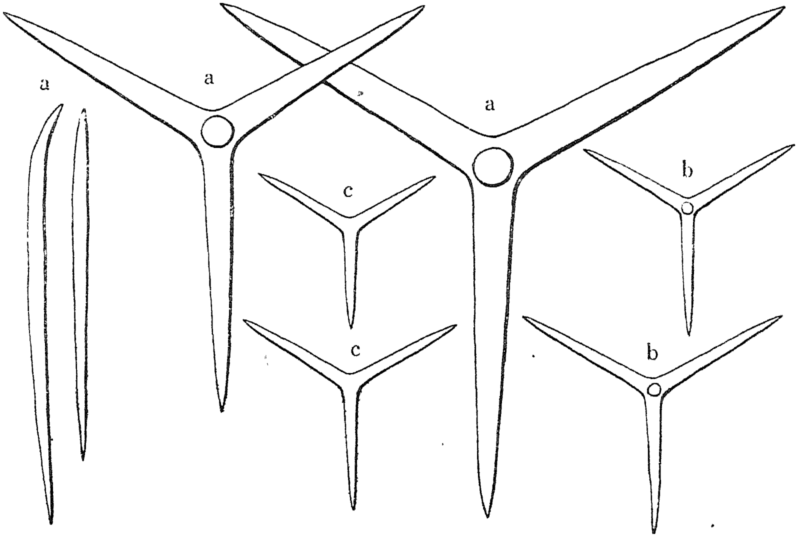
Only a single specimen (Pl. XII, fig. 16) in the collection is assigned to the present species which was collected by the writer from the sea-shore of Naha Bay, Okinawa Prefecture.

The sponge is consisted of loosely anastomosing Ascon-tubes which are separated from one another by the well-developed interspaces. The lower surface of the sponge exhibits several protuberances with which the sponge attaches to the substratum. The total length is 13 mm and the breadth is 6 mm. The diameter of the Ascon-tubes is about 0.8 mm and the surface of the tubes appears slightly hispid when observed with the naked eye on account of projecting oxea.

The colour in the preserved state is faint yellowish grey.

Structure:— The skeleton consists of triradiates, of quadriradiates, and of oxea. The quadriradiates are much more numerous than the triradiates and are of two kinds, larger and smaller. All radiates are arranged in a few layers without any definite orientation except for that they run parallel to the surface of the tubes. The apical rays of both larger and smaller quadriradiates project into the gastral cavity in large number. The oxea occur here and there without any definite direction in the sponge wall and project beyond the surface.

Spicules (Text-fig. 4):— Large quadriradiates (a) regular. Facial rays stout, straight, tapering to sharp ends, 200–230 μ long and 30–45 μ thick at base. Apical ray straight, sharply pointed, thinner and shorter than facial rays, 150–210 μ long and 22–36 μ thick at base.



Text-fig. 4. *Leucosolenia atlantica*, THACKER. a, large quadriradiates; b, small quadriradiates; c, triradiates; d, oxea. All × 150.

Smaller quadriradiates (b) also regular. All rays straight, sharply pointed. Facial rays measures 90–130 μ in length and 8–13 μ in thickness at base. Apical ray is 70–160 μ in length and 6–10 μ in thickness at base.

Triradiates (c) similar to smaller quadriradiates in shape and size, except for the absence of apical ray.

Oxea (d) slender, tapering to both ends, either straight or slightly curved, 300–450 μ long and 10–15 μ thick in the middle part.

Previously known Distribution:— Cape Verde Island, 20 fathoms (THACKER).

Locality:— Naha, Okinawa Prefecture, Littoral zone.

Remarks:— This species was first described by THACKER as fouud in Cape Verde Island and since then no one has reported this form from any where else. This is, therefore, the second report dealing with the occurrence of this species in the world.

20. **Leucosolenia australis** BRØNDSTED

(Pl. XII, fig. 17)

Lucosolenia australis, BRØNDSTED, 1928, pp. 15–17, text-figs. 15, 16; TANITA, 1942, p. 84.

This species is represented by six specimens in the collection. Of these, three were collected by Dr. SATÔ from the pearl oyster bed of Usa in Kôti Prefecture, while the remaining three were obtained by the writer himself from the pearl oyster bed of Hamajima in Mie Prefecture. They are all alike in appearance, being composed of loosely branched Ascon-tubes. The Ascon-tube is very slender, measuring only 0.8 mm in diameter and is provided with a small circular osculum at its extremity. The outer surface of the tubes is minutely hispid on account of the projecting oxea. The colour in alcohol vary from nearly white to yellowish white and the texture is soft.

The canal system of the sponge is of DENDY's type simplicia[1]. The skeleton consists of triradiates, quadriradiates, and oxea. With regard to the shape and the dimensions of spicules, these specimens are identical with the original description given by BRØNDSTED.

Previously known Distribution:— Observatory Bay, Kerguelen (BRØNDSTED).

Localities:— Usa, Kôti Pref; Hamajima, Mie Prefecture.

Remarks:— This species was described for the first time by BRØNDSTED in 1928, the specimens being taken by the "Deutschen Südpolar Expedition" from the Observatory Bay. He has given in his description two figures of spicules, but has no photographs. The writer, therefore, has appended it here.

Judging from the softness of the sponge and the conditions of the localities, this species seems to be found only in the calm bay.

21. **Leucosolenia eleanor** URBAN

(Pl. XII, fig. 18)

Leucosolenia eleanor, URBAN, 1905, pp. 36–55, Pl. 6, figs. 1–62, Pl. 7, figs. 63–68; DENDY and ROW, 1913, p. 722; LAUBENFELS, 1932, pp. 8–9, text-fig. 3; TANITA, 1942, p. 84.

There is a single specimen of this species in the collection which was collected by Dr. SATÔ from the beach of Sukumo-Ôsima in Kôti Prefecture.

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[1] DENDY, A. Trans. Roy. Soc. Victoria, Vol. 3, 1891, p. 24.

The sponge is a flattened colony of branching and anastomosing Ascon-tubes, varying from 0.4 mm to 1.5 mm in diameter. The Ascon person are thin walled tubes, each when fully grown bearing a small circular osculum at its apex. Many small blind outgrowths are seen on the lateral side of the tubes. These outgrowths seem to be young buds of the Ascon-persons.

The colour in spirit is nearly white and the texture is rather soft.

Previously known Distribution:— Coast of California (URBAN, LAUBENFELS).

Locality:— Sukumo-Ôsima, Kôti Prefecture.

Remarks:— This species was hitherto recorded only from the coast of California. From the Japanese waters, this species was obtained for the first time in the present collection.

22. Leucosolenia izuensis TANITA

(Pl. XII, fig. 19)

Leucosolenia izuensis, TANITA, 1942, pp. 21-23, Pl. 2, fig. 1, text-fig. 1; p. 81.

The collection contains three specimens of this species, of which the largest one (Pl. XII, fig. 19) was collected in the neighbourhood of the Amakusa Marine Biological Station, while the remaining two were obtained from the coast of Naha Bay.

Each of the specimens consists of branched and anastomosing Ascon-tubes and attached to the substratum directly. The specimen came from Amakusa attains a length of about 15 mm. The diameter of the Ascon-tubes varies from 0.5 mm to 1.8 mm and the dermal surface of the tubes has a hispid appearance owing to the projecting oxea.

The colour of the sponge in alcohol is faint grey.

With respect to the canal system, spiculation, and etc., these specimens at hand agree well with the type.

Previously known Distribution:— near Simoda (TANITA).

Localities:— Amakusa-Tomioka; Naha, Okinawa Prefecture.

23. Leucosolenia laxa KIRK

(Pl. XII, fig. 20)

Leucosolenia laxa, KIRK, 1895, pp. 208-209, Pl. 4, fig. 1; DENDY and ROW, 1913, p. 722; HÔZAWA, 1928, p. 220, Pl. 1, figs. 4, 5; 1940, p. 35; TANINA, 1941, p. 2, Pl. 1, fig. 1; p. 265; 1942, p. 23; p. 83.

The collection contains numerous specimens of this species which were obtained from eight different localities.

The specimens came from Miyako, which were collected by Mr. Tominaga in 1935, consist of a massive assemblage of reticulating Ascon-tubes and are contaminated with mud, looking grey.

The specimen from Ago Bay (Pl. XII, fig. 20) which was secured by the writer from the pearl oyster bed and is the largest of all, shows a massive colony of branching Ascon-tubes, attaining about 25 mm in breadth and its colour in alcohol is dirty yellow.

The remaining specimens vary a good deal both in shape and size, and some of them are fragments. Their colour varies from nearly white to yellowish grey.

Previously known Distribution:— New Zealand (Kirk). *In Japan* — Mutu Bay (Hôzawa, Tanita); Rikuzen-Ôsima (Hôzawa); Onagawa Bay; Awa-Kominato; Tateyama; Kamakura; Simoda (Tanita).

Localities:— Miyako Bay, Iwate Pref.; Ago Bay, Mie Pref.; Siono-misaki, Wakayama Pref.; Hososima, Miyazaki Pref.; Izumo-Kagamura and Esumi, Simane Pref.; Higasi-Sirahama, Wakayama Pref.; Sado-Aikawa.

Remarks:— Judging from the localities of this species above mentioned and from the number of the specimens obtained, the present form seems to be one of the species widely distributed in the Japanese waters.

24. **Leucosolenia mollis** Tanita

Leucosolenia mollis, Tanita, 1941, pp. 265–267, Pl. 17, fig. 2, text-fig. 1; 1942, p. 84.

Distribution:— Onagawa Bay (Tanita).

Remarks:— This species was described for the first time by the present writer in 1941, using the specimens obtained from Onagawa Bay.

25. **Leucosolenia pyriformis**, n. sp.

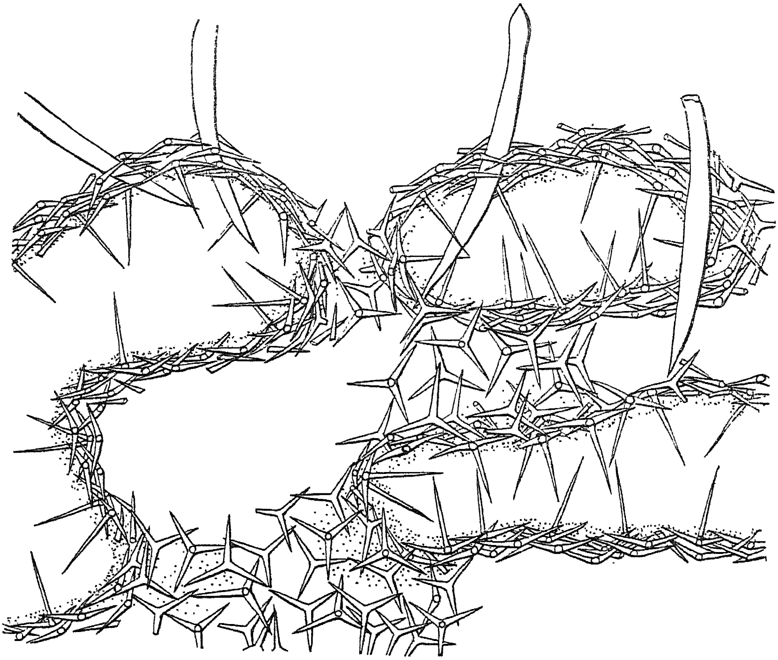
(Pl. XII, fig. 21; Text-figs. 5, 6)

This species is based upon a single specimen (Pl. XII, fig. 21) in the collection which was secured by means of a coral-dredge from a depth of 70–90 fathoms of Hayata-ura in Mie Prefecture.

The sponge represents an irregular pear-shaped colony with a height of 11 mm and a diameter of 7 mm in the middle of the body. The osculum at the summit of the body is irregular in shape and has no fringe. The body has the surface reticulated. The pseudoderm is hispid owing to the projecting oxea and is perforated by numerous pseudopores which are nearly circular in shape with a diameter of 0.3–1 mm.

The colour in alcohol is white and the texture is soft but rather elastic.

Structure (Text-fig. 5) :— The canal system of this sponge belongs to DENDY's type B in section *Reticulata*[1].



Text-fig. 5. *Leucosolenia pyriformis*, n. sp. Part of a cross-section. ×60.

The skeleton is composed of triradiates and quadriradiates, as well as oxea. The former two kinds of spicules are arranged irregularly in several layers in the sponge wall. The apical rays of the quadriradiates project fairly deeply into the gastral cavity. The oxea occur here and there in the sponge wall without any definite orientation, and project from the surface to some extent.

Spicules (Text-fig. 6) :— Triradiates of Ascon-tubes (a) regular. Rays straight, tapering to sharp end, 130–190 μ long and 12–18 μ thick at base.

Quadriradiates of Ascon-tubes (b, c) also regular. Facial rays exactly similar to the triradiates of the same. Apical ray is straight, sharply pointed, longer and slightly thinner than facial rays, 150–260 μ long and 8–15 μ thick at base.

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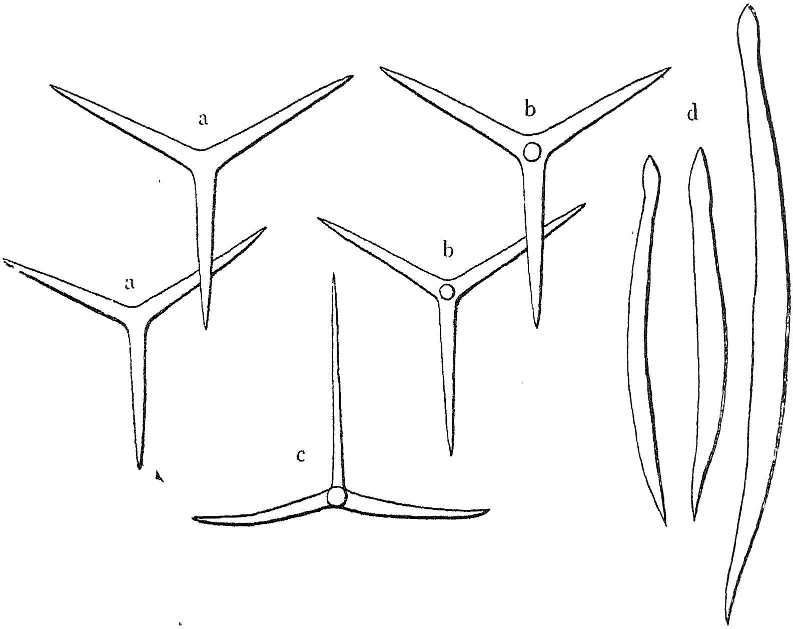
[1] DENDY, A. Trans. Roy. Soc. Victoria, Vol. 3, 1891, p. 26.

Oxea (d) elongate spindle-shaped, usually slightly curved, tapering towards both ends, one of which, namely the distal, is provided with an indistinct lance-head, 630–800 μ long and 40–55 μ thick in the thickest part.



Text-fig. 6. *Leucosolenia pyriformis*, n. sp. a, triradiates of Ascon-tube; b, quadriradiates of Ascon-tube; c, same from lateral side; d, Oxea. a–c ×150, d ×90.

Locality :— Off Hayata-ura in Mie Prefecture, 70–90 fathoms.

Remarks :— This new species seems to bear a striking resemblance to *Leucosolenia reticulum* (O. SCHMIDT)[1] and *L. sagamiana* HÔZAWA[2] in spiculation, but it may be easily distinguished from these species not only by its external appearance but also by the canal system, by the greater dimensions of spicules, and especially by the lance-headed oxea.

26. Leucosolenia reticulum (O. SCHMIDT)

Nardoa reticulum, O. SCHMIDT, 1862.
Nardopsis reticulum, HAECKEL, 1870, p. 247.
Tarrus reticulatus, HAECKEL, 1870, p. 244.
Ascandra reticulum, HAECKEL, 1872, p. 87, Pl. 14, fig. 4, Pl. 20; LENDENFELD, 1891, p. 233, Pl. 8, figs. 7, 15; BREITFUSS, 1897, p. 214; 1898, p. 23; p. 92.

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[1] *Nardoa reticulum*, O. SCHMIDT, 1864, p. 18, Pl. 1, fig. 8.
[2] *Leucosolenia sagamiana*, HÔZAWA, 1929, p. 281, Pl. 1, figs. 1, 2.

Leucosolenia reticulum, Dendy and Row, 1913, p. 723; Breitfuss, 1932, p. 243; 1935, p. 14; Topsent, 1936, p. 22, figs. 10, 11; Hôzawa, 1940, p. 32, text-fig. 2; Tanita, 1942, p. 82.

Clathrina reticulum, Minchin, 1896.

Distribution:— Adria Sea (O. Schmidt, Haeckel, Lendenfeld, Breitfuss); Greenland (O. Schmidt); New Foundland (Breitfuss); Banyuls (Topsent); Napoli (Vosmaer). *In Japan*—Wagu, Mie Pref. (Hôzawa).

27. **Leucosolenia sagamiana** Hôzawa

Leucosolenia sagamiana, Hôzawa, 1929, pp. 281–282, Pl. 1, figs. 1, 2, text-fig. 1; Tanita, 1942, p. 82.

Distribution:— Off Odawara, Sagami Sea, 171 meters (Hôzawa).

Remarks:— This species was described for the first time by Hôzawa in 1929, using a single specimen collected from a depth of 171 meters in the Sagami Sea. Since then, it has not been hitherto obtained from the adjacent seas of Japan. This form seems to be found only in the deep sea.

28. **Leucosolenia tenera** Tanita

(Pl. XIII, fig. 22)

Leucosolenia tenera, Tanita, 1940, pp. 166–168, Pl. 8, fig. 2, text-fig. 1; 1941, p. 2, Pl. 1, fig. 2; p. 267; 1942, p. 27; p. 85.

Many specimens of this species exist in the collection. Some of them were obtained by Professor Hôzawa and the writer from oyster beds of Kesennuma and of Kii-Nagasima, while some others were secured by the writer himself from the pearl oyster beds in Toba and Ago Bay, and the remaining ones were collected in the neighbourhood of the Amakusa Marine Biological Station.

Each of the specimens forms a loose, branching mass of Ascon-tubes of variable size. The Ascon-tubes are thin-walled, and some of them bear a small circular osculum at each extremity, while others are blind. The surface of the tubes is minutely hispid on account of projecting oxea.

The colour in alcohol is dirty grey due to the contamination with mud.

Previously known Distribution:—Matusima Bay: Mutu Bay; Onagawa Bay; Misaki; Bôsyû-Sunosaki (Tanita).

Localities:— Kesennuma, Miyagi Pref.; Toba Bay, Ago Bay, Kii-Nagasima, Mie Pref.; Tomioka, Kumamoto Pref.

Remarks:— This species was first described by the present writer in

1940, using the specimens obtained from Matusima Bay. Since that time, it was reported by the writer as found in several localities. Thus, by the present collections, it became clear that this species occurs along the Pacific coast of Japan proper from Amakusa in the south to Mutu Bay in the north. Judging from the localities above-mentioned, the present species seems to be rather common in the adjacent seas of Japan.

Genus **Dendya** BIDDER (1898)

Diagnosis:— Sponge colony consisting of a large central individual lined by collared cells, from which radially arranged diverticula are given off. Skeleton composed of equiangular triradiates to which quadriradiates may be added. Subgastral sagittal radiates never present. Nuclei of collared cells probably always basal.

29. **Dendya quadripodifera** HÔZAWA

(Pl. XIII, fig. 23)

Dendya quadripodifera, HÔZAWA, 1929, pp. 287–289, Pl. 2, figs. 8, 9, text-fig. 4.

This interesting species is represented by two specimens in the collection. They were collected by means of a coral-dredge at a spot off Hayataura in the Mie Prefecture from a depth of 70–90 fathoms.

The largest specimen (Pl. XIII, fig. 23) is a solitary individual attached by the base to the substratum and is of the cylindrical form. It measures 12.5 mm in length and 5 mm in diameter. The osculum at the summit of the body is elliptical in shape with a diameter of 1.2–0.8 mm and it leads into a straight wide gastral cavity. The dermal surface has a reticulate appearance on account of the perforation by numerous pores which are variable in diameter being from 0.4 mm to 1 mm. The facial rays of huge quadriradiates may be easily seen on the dermal surface using a hand-lens. The sponge wall is about 2 mm thick in the middle part of the body.

The smaller specimen is 4 mm long but the basal part of the body was torn off.

The colour in spirit is white with faint greyish tint.

With respect to the minute structure, spiculation, and etc., the present specimens are entirely identical with the type.

Previously known Distribution:— off Ôsima in the Sagami Sea, 50–100 fathoms (HÔZAWA).

Locality:— off Hayataura in Mie Prefecture, 70–90 fathoms.

Remarks:— This species was first described by HÔZAWA (1929), using a single specimen obtained from the Sagami Sea. The present paper, therefore, informs the occurrence of this form in our country for the second time. This species seems probably to be found only in the deep sea, for the type specimen was secured from a depth of 50–100 fathoms and the specimens at my hand were collected from a depth of 70–90 fathoms.

The most conspicuous feature of this species is the possession of the special huge quadriradiates in the dermal position and by this characteristics it may be easily distinguished from the other members of the genus.

30. **Dendya triradiata**, n. sp.

(Pl. XIII, figs. 24, 25; Text-figs. 7, 8)

In the collection there exist two specimens upon which this new species was established. They were obtained by the writer in 1940 from the shore of Naha Bay, Okinawa Prefecture.

The larger specimen (Pl. XIII, fig. 24) which is herewith made the type of this species, is irregularly cylindrical tube in form and is more or less laterally compressed. Two protuberances arise near the lower part by which the sponge attached to the substratum. The total length is 13 mm and the greatest breadth is 8 mm. An osculum opens at the top of the body. It is naked, circular in shape with a diameter of 1.5 mm and leads into the gastral cavity. The dermal surface is not hispid, but is uneven due to the presence of several protuberances, and are perforated by numerous round pores. The gastral surface appears nearly smooth to the naked eye.

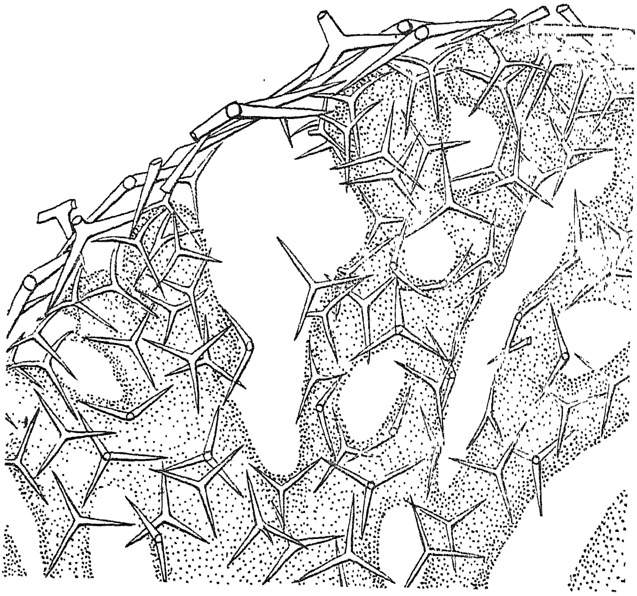
The smaller specimen (Pl. XIII, fig. 25) has the form of a nearly oval sac with a height of 6 mm and a diameter of 7 mm. The dermal surface of this specimen is smooth and nearly even. At the upper end a circular osculum opens.

The colour in alcohol is pure white and the texture is rather soft.

Structure (Text-fig. 7):— The canal system is of the asconoid type. From the central individual radially arranged diverticula are given off. The radial tubes are 160–300μ in diameter and are branched in distal part and contact each other forming a mesh-like structure.

The skeleton of the outer surface of the sponge is composed of large regular triradiates arranged tangentially in one or two layers. The inner part of the sponge, namely the distal parts of radial tubes, are formed of several small sagittal triradiates with their basal rays inwardly directed.

The walls of central Ascon-tube and of the radial tubes are consisted of small triradiates and of quadriradiates which are arranged in a single layer without any definite orientation. Apical rays of quadriradiates project into the gastral cavity and into the cavities of radial tubes.



Text-fig. 7. *Dendya triradiata*, n. sp. Part of a cross-section; ×80.

Spicules (Text-fig. 8) :— Dermal triradiates (a) regular and very large. Rays straight, gradually and sharply pointed, 220–250 μ long and 20–26 μ thick at base.

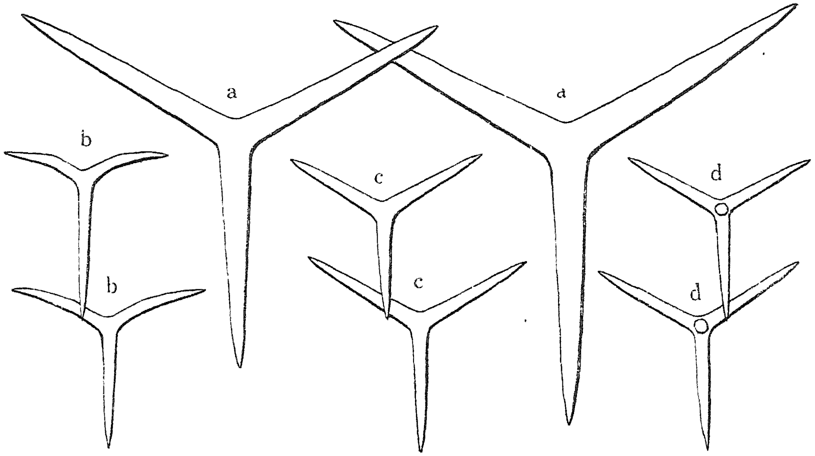
Subdermal triradiates (b) sagittal. Basal ray straight, sharply pointed, longer than paired rays, 110–125 μ long and 8–10 μ thick at base. Paired rays equal, widely divergent, curved backwards, 70–90 μ long and 8–10 μ thick at base.

Triradiates of central Ascon-tube and of radial tubes (c) regular. Rays slender, straight, tapering to sharp end, 90–110 μ long and 8–10 μ thick at base.

Quadriradiates of central Ascon-tube and of radial tubes (d) are exactly similar to triradiates of the same portion, differing only in the presence of apical ray. Apical ray straight, sharply pointed, longer and slightly thinner than facial rays, 100–160 μ long and 6–9 μ thick at base.

Locality :— Naha Bay, Okinawa Prefecture, Littoral zone.

Remarks:— This species seems to be quite distinct from any of the hitherto known species of the genus. It is remarkable for the presence of huge regular triradiates in the outer surface.



Text-fig. 8. *Dendya triradiata*, n. sp. a, dermal triradiates; b, subdermal triradiates; c, triradiates of central Ascon-tube and of radial tubes; d, quadriradiates of the same. All × 150.

B. Family **Leucascidae** DENDY

Diagnosis:— Sponge typically forming a massive colony, usually with several or many oscula, but sometimes integrated into a single individual with definite external form. Without any large central gastral cavity lined by collared cells, but with an exhalant canal system devoid of collared cells. Flagellate chambers ranging from long and possibly branched, with a tendency to radial arrangement round the exhalant canals, to small, approximately spherical, and scattered. With a distinct and independent dermal membrane (or cortex) pierced by true dermal pores. Skeleton consisting mainly of equiangular and equiradiate spicules, which may become sagittal at the oscular margins. Radiates of the chamber layer without definite arrangement, but irregularly scattered in the walls of the elongated chambers, or between the small, scattered chambers. No subgastral sagittal radiates. Nuclei of collared cells probably always basal.

Genus **Leucetta** HAECKEL (1872) emend.

Diagnosis:— Canal system leuconoid, with small, spherical or subspherical flagellate chambers irregularly scattered through the chamber layer.

31. Leucetta pyriformis DENDY

(Pl. XIII, fig. 26; Text-fig. 9)

Leucetta pyriformis, DENDY, 1913, pp. 11-12, Pl. 1, fig. 7, Pl. 4, fig. 3; DENDY and ROW, 1913, p. 734.

This species is represented by a unique specimen (Pl. XIII, fig. 26) in the collection which was obtained by the writer from the beach of Naha Bay, Okinawa Prefecture.

The sponge is nearly spherical in shape, attached to the substratum by its base directly and with a naked osculum at the upper end. It measures about 8 mm in height and 7 mm in diameter. The osculum is circular in shape with a diameter of about 1 mm. The dermal surface appears nearly smooth but uneven owing to the presence of the very large triradiates, which could be clearly seen on the surface with a hand-lens. The gastral cavity is narrow and is branched in an irregular manner.

The colour in alcohol is white and the texture is hard and harsh to touch.

Structure:— The canal system is of the leuconoid type. The flagellated chambers are oval or nearly spherical in shape with a diameter of 100–120 μ and are thickly packed together without any order in the chamber layer.

The dermal skeleton is consisted of several layers of large and small triradiates, both of which are regular in shape and are placed tangentially.

The tubar skeleton is also composed of large and small triradiates which are similar in shape to those of the dermal and are thickly and irregularly scattered. Among these spicules, here and there occur some intermediate triradiates. The small triradiates are much more numerous than the large one, while intermediate triradiates occur in much fewer numbers.

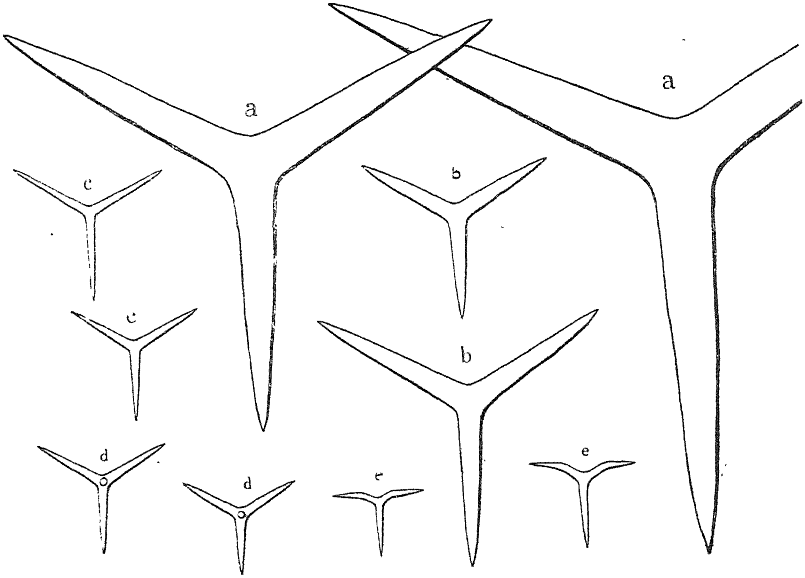
The skeleton of the gastral surface is made up of a few layers of small tri- and quadriradiates. The gastral quadriradiates are small in number and their apical rays project into the gastral cavity. The oscular margin is thin and is consisted of small sagittal triradiates with their basal rays pointed regularly downwards.

Spicules (Text-fig. 9):— Large triradiates of the dermal and tubar skeleton (a) regular. Rays stout, straight, tapering to the sharply pointed ends, variable in length, 650–970 μ long and 100–125 μ thick at base.

Intermediate triradiates (b) of chamber layer also regular. Rays straight, 250–340 μ long and 30–40 μ thick at base.

Small triradiates (c) which are found in the dermal surface, in the chamber layer, and in the gastral surface are equiradiate and equiangulate. Rays straight, sharply pointed, 150–180 μ long and 12–16 μ thick at base.

Gastral quadriradiates (d) exactly similar to the small triradiates abovementioned, but with apical ray. Apical ray straight, sharply ended, slightly shorter and thinner than the facial rays, 100–160 μ long and 10–12 μ thick at base.



Text-fig. 9. *Leucetta pyriformis* Dendy. a, large triradiates; b, intermediate triradiates; c, small triradiates; d, gastral quadriradiates; e, triradiates of oscular margin. All×60.

Triradiates of oscular margin (e) sagittal. Basal ray straight, while the paired rays curved backwards at the middle point of the ray. Both the length and the thickness of the rays are equal to those of the small triradiates of the body.

Previously known Distribution:— Cargados Carajos, Indian Ocean; 45 fathoms (Dendy).

Locality:— Naha, Okinawa Prefecture, Sublittoral.

Remarks:— This species was first described by Dendy in 1913 basing upon two specimens obtained from the Indian Ocean. Since that time, however, no one has reported this form. This is, therefore, the second report with regard to the occurrence of this species.

The present report informs the occurrence of the said genus in the waters of Japan for the first time. The same fact may be also said of the family Leucascidae to which the genus *Leucetta* belongs.

C. Family **Leucaltidae** DENDY and ROW

Diagnosis:— Sponge colony tubular and ramified, or even anastomosing, with many oscula, or individualised with large central cavity and single osculum. Wall of colony composed of at least two distinct layers, namely, a dermal cortex with strongly developed skeleton of tangential radiates, and a chamber layer with a skeleton greatly reduced or even absent. A thin gastral cortex or membrane may or may not be present. Skeleton composed, mainly at any rate, of equiangular radiates. No sub-gastral sagittal radiates. Nuclei of collared cells probably always basal.

Genus **Leucaltis** HAECKEL (1872) emend.

Diagnosis:— Sponge colony tubular, ramified and anastomosing, with many oscula. Flagellate chambers elongated and branched, more or less radially arranged round the central gastral cavities of the tubes.

32. **Leucaltis clathria** HAECKEL

(Pl. XIII, fig. 27)

Leucaltis clathria, HAECKEL, 1872, pp. 159–161, Pl. 28, fig. 3; DENDY, 1913, p. 16, Pl. 2, figs. 1, 2; DENDY and ROW, 1913, p. 738; HÔZAWA, 1940, p. 136, Pl. 6, fig. 3.
Heteropegma nodus gordii, POLÉJAEFF, 1883, pp. 45–46, Pl. 1. fig. 7, Pl. 4, figs. 1a–1d; LENDENFELD, 1885, pp. 1107–1109; DENDY, 1892, p. 113; 1893, p. 204, Pl. 13, fig. 2; 1905, p. 230; HANITSCH, 1895, p. 209; JENKIN, 1908, p. 453, text-fig. 103.
Leucaltis bathybia var. *mascarenica*, RIDLEY, 1884.
Clathrina latitubulata, CARTER, 1886, pp. 515–516.
Heteropegma latitubulata, DENDY, 1892, p. 114.

This species is represented in the collection by a single specimen (Pl. XIII, fig. 27) which was obtained from the shore of Naha in 1940.

The sponge represents a solitary individual of an elongate cylindrical form, broadest at the middle of the body and tapering towards both ends. It is 8 mm in length and is 4.5 mm in diameter. The osculum at the upper end is naked and is nearly circular in shape with a diameter of 0.5 mm. The dermal surface is nearly smooth and the body wall is 1.5 mm thick. The colour in spirit is white and the texture is hard.

It is unnecessary to add any further details with regard to the minute structure, for it has been already recorded by previous investigators. The general anatomy of the species has been figured by POLÉJAEFF and DENDY, and the spicules have been already figured satisfactorily by HAECKEL, POLÉJAEFF, and JENKIN.

Previously known Distribution:— Coast of Florida (HAECKEL); off Bermudas (POLÉJAEFF); Cape York, Torres Straits (POLÉJAEFF); near Port Phillip Heads (CARTER, DENDY); Ceylon (DENDY); West Coast of Portugal (HANITSCH); Amirante Group, Seychelles (RIDLEY, DENDY); Wasin E. Africa (JENKIN); Cargodas Carajos (DENDY); Egmont Reef (DENDY, ROW and HÔZAWA).

Locality:— Naha, Okinawa Prefecture, Littoral zone.

Remarks:— This widely distributed species was first described by HAECKEL in 1872, using the specimens obtained from Florida. Then in 1883, POLÉJAEFF reported the species under the name of *Heteropegma nodus gardii.* Since that time several investigators such as LENDENFELD, DENDY, HANITSCH, and JENKIN recorded the species under the name proposed by POLÉJAEFF, but in 1913, DENDY has discussed that the name by POLÉJAEFF is synonymous with the present species. DENDY also mentioned in his same paper that both of *Leucaltis bathybia* var. *mascarenica* RIDLEY and *Clathrina latitubulata* CARTER are synonymous to this species.

Judging from the previously known distribution, this species seems to be widely distributed all over the world, but from Japan, until now, it has not been found. Thus this is the first record of this species as found in the Japanese waters.

33. **Leucaltis tenuis** HÔZAWA

Leucaltis tenuis, HÔZAWA, 1929, pp. 289–291, Pl. 2, figs. 10, 11, text-fig. 5.

Distribution:— Tikurajima in Kagosima Prefecture, depth 100 meters (HÔZAWA).

D. Family **Minchinellidae** DENDY and ROW

Diagnosis:— Canal system leuconoid (in all known forms and presumably always so). Main skeleton composed of quadriradiates cemented together in various ways by calcareous cement. Apparently without subgastral sagittal radiates. Nuclei of collared cells (probably always) basal.

Genus **Petrostroma** DÖDERLEIN (1892)

Diagnosis:— The quadriradiates of the skeleton of the chamberlayer fused together laterally by calcareous cement into a network. Dermal skeleton of separate quadriradiates and triradiates and bunches of tuning-fork spicules.

34. **Petrostroma schulzei** DÖDERLEIN

Petrostroma schulzei, DÖDERLEIN, 1892, pp. 143-145; 1898, pp. 15-32, Pls. 2-6; DENDY and ROW, 1913, p. 740; HÔZAWA, 1929, p. 291.

Distribution:— Off Enosima, Sagami Sea, depth 200-400 meters (DÖDERLEIN).

Remarks:—This is the only species of the genus *Petrostroma* which was described for the first time by DÖDERLEIN, using the specimens obtained from the Sagami Sea. This very interesting species, however, has not hitherto been reported from any other localities.

The skeleton of the chamber layer of this sponge are fused together by calcareous cement to form a network and the dermal cortex is provided with the tuning-fork spicules.

E. Family **Sycettidae** DENDY

Diagnosis:— Flagellate chambers elongated, arranged radially around a central gastral cavity, their ends projecting more or less on the dermal surface and not covered over by a continuous dermal cortex strengthened by tangential dermal spicules. Tubar skeleton articulate, with subgastral sagittal radiates. Collared cells usually confined to the radial chambers in the adult, and probably always with apical nuclei.

Genus **Sycetta** HAECKEL (1872) emend.

Diagnosis:— The radially arranged flagellate chambers always completely separate from one another, and never possessing tufts of oxea at their distal ends. With no properly defined inhalant canals leading to the prosopyles.

35. **Sycetta conifera** (HAECKEL)

Sycaltis conifera, HAECKEL, 1872, pp. 264-266, Pl. 45, figs. 1-3.
Sycon conifera, POLÉJAEFF, 1883, p. 24.
Sycetta conifera, LENDENFELD, 1892, p. 239, Pl. 11, fig. 74; DENDY and ROW, 1913, p. 743; HÔZAWA, 1929, pp. 292-294, text-fig. 6.

Distribution:— Adriatic Sea (HAECKEL, LENDENFELD); *In Japan* — Off Yamakawa, Kagosima Bay, depth 100 meters (HÔZAWA).

36. **Sycetta quadriradiata** HÔZAWA

Sycetta quadriradiata, HÔZAWA, 1929, pp. 294-295, Pl. 2, figs. 12, 13, text-fig. 7; 1940, p. 36.

Distribution :— Kagosima Bay, depth 100 meters; Wagu in Mie Prefecture (Hôzawa).

Remarks: — This species was first described by Hôzawa (1929), the specimen being taken from a depth of 100 meters in Kagosima Bay. Afterwards it was reported by the same author as found in the adjacent sea of Kii Peninsula. None of the specimens of this species, however, are contained in the present collections.

Genus Sycon Risso (1826) emend.

Diagnosis :— Radial chambers usually more or less united at places where they come into contact with one another, and always crowned distally with tufts of oxeote spicules. Properly defined inhalant canals usually present, the outer ends of which may be covered by a thin pore-bearing dermal membrane without special skeleton.

37. **Sycon album** Tanita

Sycon album, Tanita, 1942, pp. 28–30, Pl. 2, fig. 6, text-fig. 3.

Distribution :— Okinosima, off Bôsyû-Tateyama (Tanita).

Remarks :— The present species was first described by the present writer, using a single specimen collected from Okinosima. As mentioned in the original paper, the main characteristic of this species is the repeatedly branched flagellated chambers.

38. **Sycon calcar-avis** Hôzawa

Sycon calcar-avis, Hôzawa, 1929, pp. 304–307, Pl. 3, figs. 20, 21, text-fig. 11.

Distribution :— Off Odawara, Sagami Sea, depth 170 meters (Hôzawa).

39. **Sycon ciliatum** (Fabricius)

Spongia ciliata, Fabricius, 1780, p. 448.

Grantia ciliata, Johnston. 1842, p. 176, Pl. 20, figs. 4, 5, Pl. 21, figs. 6, 7; Gray, 1867, p. 554.

Sycum giganteum, Haeckel, 1870, p. 239.

Sycocystis oviformis, Haeckel, 1870, p. 249.

Sycodendrum ramosum, Haeckel, 1870, p. 245.

Sycon ciliatum, O. Schmidt, 1870, p. 74; Breitfuss, 1897, p. 216; 1898, p. 18, Pl. 1, figs. 9–12; p. 23; 1927, p. 29; 1932, p. 244; 1936, p. 6; Dendy and Row, 1913, p. 745; Row and Hôzawa, 1931, p. 756; Burton, 1933, p. 236; Tanita, 1941, p. 268, Pl. 17, fig. 3.

Sycandra ciliata, Haeckel, 1872, p. 296, Pl. 51, fig. 1, Pl. 58, fig. 9; Arnesen, 1901, p. 16.

Seventeen specimens contained in the collection have been assigned to this well-known species. Each of the specimens is small and solitary, provided with an osculum at the upper end and is surrounded by a well-developed collar. Each of the specimens represents an elongated oval form and is attached by its base to the foreign object. They vary from 3 mm to 7 mm in length but are all nearly similar is appearance.

The colour of the specimens is nearly white with faint yellowish tint.

Previously known Distrbution :— Cosmopolitan : Arctic Ocean ; North Atlantic coast of Europe ; North America ; Adriatic Sea ; South-west Australia. *In Japan* — Onagawa Bay (TANITA).

Localities :— Tanabe Bay and Kata, Wakayama Prefecture.

Remarks : — This is the second report dealing with the occurrence of this species in Japan.

40. **Sycon coronatum** (ELLIS and SOLANDER)

(Pl. XIII, figs. 28, 29)

Spongia coronata, ELLIS and SOLANDER, 1786, p. 190, Tab. 58, figs. 8, 9.
Sycandra coronata, HAECKEL, 1872, p. 304, Pl. 51, fig. 2, Pl. 60, figs. 1–6.
Sycon coronatum, DENDY, 1892, p. 79; DENDY and ROW, 1913, p. 745; LAUBENFELS, 1932, p. 11; BREITFUSS, 1935, pp. 16–17; HÔZAWA, 1940, pp. 140–143, Pl. 6, fig. 5, text-fig. 4; TANITA, 1941, p. 2.

A great number of specimens of this species were obtained from various localities in Kii Peninsula, Sikoku, and Kiusyû. Of which, two were collected in the neighbourhood of the Amakusa Marine Biological Station, two were obtained from Tosa-Tatugusi by Dr SATÔ, while the remaining specimens were secured by the writer himself from Momotori, Owasi, Uwajima, and Sukumo-Ôsima.

They are either nearly oval or elongated sac-like in form, provided with a terminal osculum. The largest specimen measures 9 mm in length and 4.5 mm in the greatest diameter. The osculum at the upper end of the sponge is circular in shape and is surrounded by a collar. The surface of the sponge is highly hispid owing to the projecting oxea.

The colour in the preserved state is either white or grey.

Previously known Distribution :— Cosmopolitan : East coast of Australia (HAECKEL, LENDENFELD, DENDY) ; Atlantic Ocean (HAECKEL, BREITFUSS) ; Pacific Ocean (HAECKEL) ; Indian Ocean (ROW) ; Messina (HÔZAWA). *In Japan* — Mutu Bay (TANITA).

Localities :— Momotori-mura and Owasi, Mie Pref.; Tatugusi and Sukumo-Ôsima, Kôti Pref.; Uwajima, Ehime Pref.; Tomioka, Kumamoto Pref.

Remarks:— The writer has already reported on the occurrence of this species in Japan. As shown in the above, this species seems to occur very commonly along the coasts of Japan.

41. **Sycon cylindricum** TANITA

(Pl. XIII, fig. 30)

Sycon cylindricum, TANITA, 1942, pp. 30–32, Pl. 2, fig. 7, text-fig. 4.

Only two specimens in the collection are assigned to this species. They were obtained by the writer from the shore of Momotori-mura, near Toba.

The first specimen (Pl. XIII, fig. 30) is a solitary individual, cylindrical in form and is 3 mm in the greatest breadth. The osculum at the upper end is surrounded by a feebly-developed collar. The colour in alcohol is yellowish white.

The second specimen is nearly the same as the first in shape, attaining 7.5 mm in length.

With respect to the inner structure, spicules, and etc., the specimens at hand are identical with the type.

Previously known Distribution:— Simoda (TANITA).

Locality:— Momotori-mura, near Toba in Mie Prefecture.

Remarks:— This species was first described by the writer in 1942, the specimen being taken from the neighbourhood of the Mitsui Institute of Marine Biology. As mentioned in the writer's previous paper (1942, p. 32), the peculiarities of this species exist in the presence of two sorts of oxea at the distal ends of flagellated chambers and in the fact that the flagellated chambers are divided distally into two or three branches.

42. **Sycon digitiformis** HÔZAWA

Sycon digitiformis, HÔZAWA, 1929, pp. 307–310, Pl. 4, figs. 22, 23, text-fig. 12.

Distribution:— Sagami Sea, depth 357 meters (HÔZAWA).

43. **Sycon ensiferum** DENDY

(Pl. XIII, fig. 31)

Sycon ensiferum, DENDY, 1892, p. 81; DENDY and ROW, 1913, p. 746; ROW and HÔZAWA, 1931, p. 756, Pl. 20, fig. 8.

I have identified a single specimen in the collection with this species. It was obtained by the writer from the shore of Naha Bay.

It is of nearly cylindrical shape with the lower part bent, measuring 9 mm in length and 4 mm in diameter. The osculum at the upper end of the body appears nearly naked and is circular in shape with a diameter of 1 mm. The colour in the preserved state is yellowish white.

The canal system, the skeletal arrangement, and the spiculation agree well with those of the type.

Previously known Distribution:— Near Port Phillip Heads (DENDY); Bunbury Bay (ROW and HÔZAWA).

Locality:— Naha, Okinawa Prefecture.

Remarks:— This species was described for the first time by DENDY in 1892, and afterwards, it was reported by ROW and HÔZAWA in 1931, both from the shores of Australia. This is the first record of this species as found in the Japanese waters.

This species may be distinguished from the other members of the genus by the following remarkable features: 1) the apical rays of the gastral quadriradiates are very strongly developed, being swollen into long club-shaped form, but fairly sharply pointed and only very slightly curved, much broader in the distal half than in the proximal, 2) the tubar skeleton is composed of tri- and quadriradiates, and 3) the basal rays of the most distally situated tubar triradiates are very strongly bent outwards from the wall of the chamber, so as to curve over and protect the entrances to the inhalant canals.

44. **Sycon globulatum** HÔZAWA

Sycon globulatum, HÔZAWA, 1929, pp. 312–314, Pl. 4, figs. 26, 27, text-fig. 14.

Distribution:— Ejima, Province Ôsumi (HÔZAWA).

45. **Sycon lendenfeldi** ROW and HÔZAWA

(Pl. XIII, fig. 32)

Sycon lendenfeldi, ROW and HÔZAWA, 1931, pp. 757–768, Pl. 20, fig. 9, text-fig. 8; TANITA, 1941, p. 286.

This species is represented by a single specimen in the collection which was obtained by the writer from the shore of Hiuga-Utimi. The sponge shows a solitary individual attached to the substratum by means of a slender stalk. The total length of the sponge is 9 mm and the greatest diameter of the body is 2 mm. The stalk attains about 2.3 mm in length. The osculum at the upper end is circular in shape with a diameter of 1 mm and is surrounded by a feebly developed oscular collar. The surface of the body is hispid on account of the projecting oxea. The colour in the preserved state is nearly white but is somewhat dirty.

Previously known Distribution:— Fremantle District; Albany District of Australia (Row and HÔZAWA). *In Japan* — Onagawa Bay (TANITA).

Locality: — Hiuga-Utimi, Miyazaki Prefecture.

Remarks:— This species was originally described by Row and HÔZAWA in 1931. Afterwards, it was reported by the writer as found in the Japanese waters. This is the second case that dealt with this sponge from the adjacent seas of Japan.

46. **Sycon luteolum** TANITA

(Pl. XIII, fig. 33)

Sycon luteolum, TANITA, 1942, pp. 32–35, Pl. 2, fig. 8, text-fig. 5.

Many specimens of this species are included in the collection. All of them were collected by the writer from seven different localities.

They are solitary, each being provided with a circular osculum at the upper end which is surrounded by a well-developed collar.

The largest specimen is an individual of elongated oval shape, measuring 14 mm in length and 6 mm in the greatest breadth. The body surface is strongly hispid.

The colour of the specimens in alcohol varies from nearly white to grey.

In anatomical structure and spiculation, the present specimens are identical with the type which was first described by the present writer, so that there is no need to add further descriptions.

Previously known Distribution:—Awa-Kominato; Kamakura (TANITA).

Localities:— Owasi, Mie Pref.; Aosima and Utimi, Miyazaki Pref.; Tomioka, Kumamoto Pref.; Izumo-Kagamura; Hamada, Simane Pref.; Izumo-Esumi; Hinomisaki, Simane Pref.

Remarks:— The present species is quite distinct from any of the hitherto known species of the genus *Sycon* in the following three points: 1) flagellated chambers are divided, 2) a feebly developed dermal cortex is present, and 3) the tubar quadriradiates are present.

47. **Sycon matsushimense** TANITA

(Pl. XIII, fig. 34)

Sycon matsushimense, TANITA, 1940, pp. 168–171, Pl. 8, fig. 4, text-fig. 2; 1942, p. 35.

Several specimens of this species were collected from the four different localities of Mangoku-ura, Momotori-mura, Yunotu in Simane Prefecture, and Kamo in Yamagata Prefecture. They are all closely similar in appearance, though they vary from 3.5 mm to 9 mm in length. Each of the specimens forms of an elongated sac with a circular osculum which is surrounded by a well-developed collar.

The colour in spirit is greyish white.

Previously known Distribution:— Matusima Bay; Awa-Kominato; Bôsyû Sunosaki; Simoda (TANITA).

Localities:— Mangoku-ura, Miyagi Pref.; Momotori-mura, Mie Pref.; Yunotu, Simane Pref.; Kamo, Yamagata Pref.

48. **Sycon misakiensis** HÔZAWA

(Pl. XIV, figs. 35, 36)

Sycon misakiensis, HÔZAWA, 1929, pp. 300-302, Pl. 2, figs. 16, 17, text-fig. 9; 1940, p. 37; TANITA, 1942, p. 35, Pl. 2, fig. 9.

This species is represented by numerous specimens in the collection which were obtained from six different localities. They vary from nearly oval to cylindrical in shape.

The specimen came from Kesennuma (Pl. XIV, fig. 35) shows an oval form with the length of 14 mm and the greatest diameter of 8 mm. The sponge-wall measures about 2 mm thick in the middle parts of the body.

Each of the specimens has a circular osculum at its upper end which is provided with a feebly developed collar. The colour in alcohol is either nearly white or yellowish white.

Of the canal system, skeletal arrangement, and spiculation, these specimens are entirely identical with the type, so that there are no needs to add further descriptions.

Previously known Distribution:— Misaki (HÔZAWA, TANITA); Rikuzen-Ôsima (HÔZAWA); Bôsyû-Sunosaki (TANITA).

Localities:— Kesennuma, Miyagi Pref.; Toba Bay; Hamajima in Ago Bay; Takahama, Ehime Pref.; Tomioka, Kumamoto Pref.; Izumo-Kagamura.

Remarks:— Judging from the localities above mentioned and from the numbers of the specimens obtained, this species seems to be one of the commonest Calcarea in the Japanese waters.

49. **Sycon mundulum** LAMBE

Sycon mundulum, LAMBE, 1900, pp. 28-29, Pl. 3, fig. 7; DENDY and ROW, 1913, p. 747; TANITA, 1941, p. 269, Pl. 7, fig. 4.

This species is represented by four specimens in the collection which were obtained by the writer from the shore of Wakasa-Takahama. They are nearly alike in appearance and are comparatively small, attaining only 4 mm in length. The osculum at the upper end of each specimen is circular in shape and has a feebly developed oscular collar. The colaur in spirit is nearly white.

Previously known Distribution:— Davis Strait, Exetor Harbour, depth 10 fathoms; off Cape Raper, depth 60 fathoms (LAMBE). *In Japan* — Onagawa Bay, depth 8 meters (TANITA).

Locality:— Wakasa-Takahama, depth 3 meters.

50. Sycon okadai HÔZAWA

(Pl. XIV, fig. 37)

Sycon okadai, HÔZAWA, 1929, pp. 302-304, Pl. 3, figs. 18, 19, text-fig. 10; TANITA, 1940, p. 168, Pl. 8, fig. 3; 1941, p. 269.

A great number of specimens of this species were collected at various localities shown in the Table II.

TABLE II. The localities of *S. okadai* obtained by the present collections

Locality	Nos. of specimens	Total length in mm.	Date	Collector
Kesennuma, Miyagi Pref.	60	5.0-53.0	Feb. '38	HIRAI
Momotorimura, Mie Pref.	7	11.0-20.0	Dec. '39	TANITA
Tatokujima, Ditto.	45	4.5-30.0	Jan. '40	TANITA
Kii-Nagasima, Ditto.	3	5.0-11.0	Oct. '41	HÔZAWA & TANITA
Tomioka, Kumamoto Pref.	11	8.0-25.0	Mar. '40	TANITA
Kannoura, Kôti Pref.	1	13.0	Jan. '40	SATÔ
Usa, Ditto.	2	12.0-22.0	Jan. '40	SATÔ
Sukumo-Ôsima, Ditto.	3	6.0-12.5	Jan. '40	SATÔ
Hirayama, Ehime Pref.	1	12.0	Jan. '40	SATÔ
Uwajima, Ditto.	6	14.0-62.0	April '42	TANITA
Mogi, Nagasaki Pref.	35	9.0-23.5	Mar. '40	TANITA
Ryôtu, Niigata Pref.	57	8.0-17.5	Aug. '41	TANITA
Aikawa, Ditto.	12	3.0-24.0	Aug. '41	TANITA
Nezugaseki, Yamagata Pref.	3	16.0-21.0	Aug. '35	SATÔ
Kamo, Ditto.	16	3.5-10.0	Aug. '41	HÔZAWA & SASAKI

They are nearly alike in appearance and structure, differing only in size as shown in the Table II. Most of the specimens have an osculum at each upper end which is surrounded by a membranous margin. While some of them have two oscula, but these seem to be abnormal. On such abnormality of the osculum of this species, the present writer will report in the near future.

The colour in the preserved state is white or yellowish white.

Previously known Distribution:— Misaki (HÔZAWA); Matusima Bay; Mangoku-ura; Onagawa Bay (TANITA).

Localities:— See Table II.

Remarks:— This species was described for the first time by HÔZAWA in 1929, the descriptions being based upon two specimens obtained from Misaki. Since that time, it was reported twice by the writer from the northern parts of Japan. It became clear by the present collection that this species is one of the commonest Calcarea to be met with along the coasts of Japan proper, being obtained in many localities as shown in the above Table.

51. **Sycon ornatum** KIRK

(Pl. XIV, fig. 38)

Sycon ornatum, KIRK, 1897, p. 314, Pl. 31, figs. 2a, 2b, Pl. 32, fig. 2; DENDY and ROW, 1913, p. 747; BRØNDSTED, 1926, p. 303; HÔZAWA, 1940, p. 36; TANITA, 1941, p. 269.

Many specimens of this species were collected by the writer from six different localities. They vary from 3 mm to 13 mm in total length.

Each of the specimens represents a solitary individual of an elongated cylindrical form, attached to the substratum by means of the base and shows at the upper end an osculum which is surrounded by a well-developed collar.

The colour in alcohol is dirty yellowish grey.

Previously known Distribution:— New Zealand (KIRK). *In Japan* — Rikuzen Ôsima (HÔZAWA); Onagawa Bay (TANITA).

Localities:— Toba Bay; Tatokujima and Hamajima; Owasi, Mie Pref.; Tanabe Bay, Wakayama Pref.; Tomioka, Kumamoto Pref.

Remarks:— This species was originally described by KIRK (1897) from a specimen obtained from Cook Strait, New Zealand, and afterwards, it was reported by HÔZAWA (1940) and by the writer (1941) as found in Japanese waters.

52. **Sycon plumosum**, n. sp.

(Pl. XIV, figs. 39, 40; Text-figs. 10, 11)

This new species is represented by six specimens in the collection. Of which, the first was obtained by Dr. ABE in 1935, the second was secured by Mr. HIRO in 1936, and the remaining four were collected by Mr. KATÔ in 1942 from the shores of Palao, the Carolin Islands.

The first specimen which was secured by Dr. ABE is a solitary individual of tubular form with a length of 5 mm. The basal part of the sponge was torn off. The dermal surface is strongly hispid and the colour in alcohol is white.

The second specimen which was obtained by Mr. HIRO (Pl. XIV, fig. 39) is nearly oval in form and is slightly laterally compressed. The sponge measures 8 mm in length, 7 mm in breadth and 4.5 mm in thickness. The osculum at the upper end of the body is elliptical in shape and is surrounded by a well-developed collar of about 1 mm high. The sponge wall is 1.5 mm thick in the thickest parts of the body. The colour is nearly white with faint greyish tint.

The largest specimen in the collection (Pl. XIV, fig. 40) which the writer has made the type of the species represents a solitary person of a slightly elongated oval shape. It is 33 mm long and about 22 mm broad in the middle part of the body, where the wall is about 8 mm thick. At the upper end of the body, the sponge is provided with an elliptical osculum which is 6 mm long by 5 mm broad. The dermal surface is strongly hispid owing to the projecting large oxea and the gastral is slightly rough. The gastral cavity is large and extends the entire length of the body. The colour in the preserved state is greyish white, being contaminated with mud. The texture is rather elastic.

Structure (Text-fig. 10) :— The canal system is typically syconoid. The flagellated chambers are cylindrical in form, nearly straight, unbranched, set closely, equally thick in their greater parts and are rounded at the end. They vary from 120 μ to 230 μ in diameter, while the length are variable corresponding to the thickness of sponge wall.

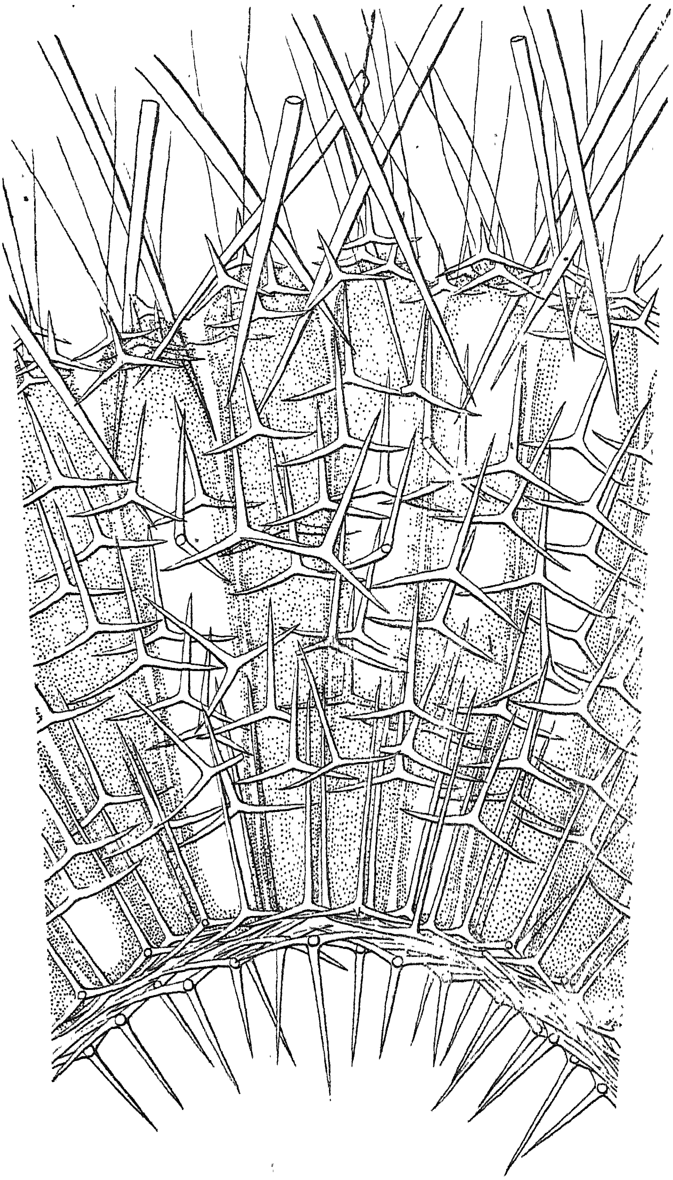
The skeleton of the distal parts of the flagellated chambers is made up of densely arranged tubar triradiates with the basal rays pointing outwardly and of several large oxea and linear spicules. Thus the distal ends of the flagellated chambers seem to form a thin dermal cortex.

The skeleton of the middle part of the body wall is arranged as usual, being composed mainly of tubar triradiates. Near the gastral cavity, the skeleton is added with basal rays of subgastral tri- and quadriradiates.

The gastral skeleton is rather thick and is distinguished fairly well from that of the chamber layer. It consists of several layers of gastral quadriradiates and of paired rays of subgastral tri- and quadriradiates.

The gastral quadriradiates are arranged tangentially with their long apical rays projecting freely into the gastral cavity.

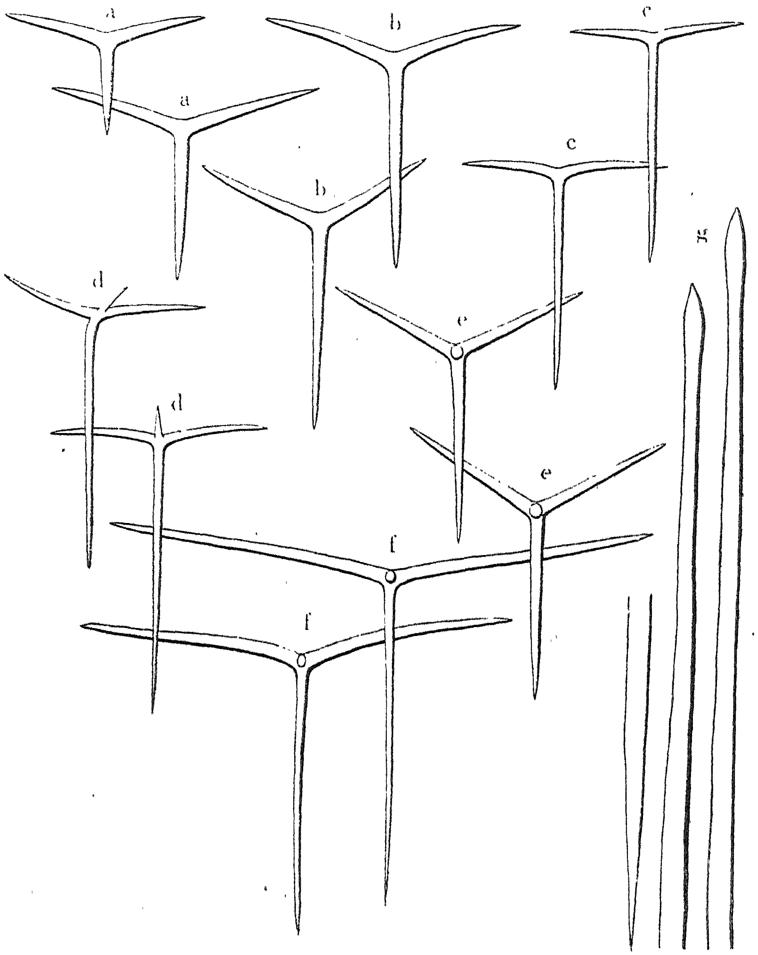
The skeleton of oscular margin is a close interlacement of longitudinally



Text-fig. 10. *Sycon plumosum*, n. sp. Part of a cross-section. ×60.

placed linear spicules and of quadriradiates which have strongly divergent paired rays and downwardly directed basal rays.

Spicules (Text-fig. 11) : — Tubar triradiates of distal parts of the flagellated chambers (a) slightly sagittal. Basal ray straight, sharply pointed, slightly shorter than paired rays, 140–200 μ long and about 16 μ thick at the base. Paired rays equal, nearly straight, widely divergent, 200–240 μ long and 16 μ thick at base.



Text-fig. 11. *Sycon plumosum*, n. sp. a, tubar triradiates of distal parts of the flagellated chambers; b, tubar triradiates of the middle parts of the body; c, subgastral triradiates; d, subgastral quadriradiates; e, gastral quadriradiates; f, quadriradiates of oscular margin; g, large oxea at the distal end of flagellated chambers. All × 90.

Tubar triradiates from the middle parts of the body (b) strongly sagittal. Basal ray straight, tapering to sharply pointed end, longer than paired rays, 270–360μ long and 15–18μ thick at base. Paired rays equal, either straight or slightly curved forwards, 170–240μ long and 15–18μ thick at base.

Subgastral triradiates (c) also strongly sagittal. Basal ray straight, sharply ended, much longer than paired rays, 250–360μ long and 8–10μ thick at base. Paired rays equal, widely divergent, either nearly straight or very slightly curved backwards, 120–180μ long and 8–10μ thick at base.

Subgastral quadriradiates (d) similar to triradiates of the same, differing only in the presence of short apical ray. Apical ray nearly straight, sharply pointed, shorter than facial rays, 70–100μ long and 8–10μ thick at base.

Gastral quadriradiates (e) sagittal. Basal ray straight, longer than paired rays, 220–280μ long and 12–16μ thick at base. Paired rays equal, nearly straight, sharply pointed, 170–200μ long and 12–16μ thck at base. Apical ray straight or slightly curved oralwards, finely pointed, variable in length, 130–350μ long and 12–16μ thick at base.

Quadriradiates of oscular margin (f) large and strongly sagittal. Basal ray straight, sharply pointed, longer and thinner than paired rays, 330–500μ long and about 10μ thick at base. Paired rays widely divergent, slightly curved backwards, 260–380μ long and 12–16μ thick at base. Apical ray short, sharply ended, curved upwards, 120–250μ long and about 10μ thick at base.

Large oxea at the distal end of flagellated chamber (g) nearly straight, slender, sharply pointed at both ends. The distal end of oxea is provided with a feebly developed lance-head, while the proximal is solely sharply pointed. They are 0.8–3 mm in length and are 30–35μ thick in the thickest part.

Linear spicules of oscular margin also sharply pointed at the both ends, nearly uniformly thick in the greater parts of the length, 2–3 mm long and 6–10μ thick in the middle part.

Hair-like oxea at the distal ends of flagellated chamber slender, uniformly thick with both ends sharply pointed. The free ends are usually found broken off. An example of the spicules measured 4.5 mm long and 3μ thick.

Locality:— Palao, Caroline Islands.

Remarks:— In external form this species bears a marked resemblance to *Sycon ramsayi* (LENDENFELD)[1], while in spiculation it approaches *S. australis* (JENKIN)[2]. LENDENFELD's species, however, differs distinctly from this species in spiculation and JENKIN's species differs from the present species not only in external appearance but also in shape and dimensions of oxea and of gastral quadriradiates. The most conspicuous features of this species are the presence of a feebly developed dermal cortex and of a well-developed subgastral radiates.

53. Sycon pulchrum, n. sp.

(Pl. XIV, fig. 41; Text-figs. 12, 13)

This new species is based upon a single specimen (Pl. XIV, fig. 41) in the collection. It was obtained by means of a coral-dredge from a depth of about 100 fathoms off Kosikijima, Kagosima Prefecture. The sponge represents a solitary individual of a short cylindrical form, attached by its base to the substratum. The total length of the sponge is 3 mm and the diameter is 1.3 mm. The osculum at the upper end is surrounded by a feebly-developed oscular collar and is circular in shape with a diameter of 1 mm. The dermal surface of the sponge is hispid due to the projecting oxea and the gastral surface is also hispid on account of long apical rays of gastral quadriradiates.

The colour of the sponge is quite white and the texture is soft.

Structure (Text-fig. 12):—The canal system is of the syconoid type. The flagellated chambers are cylindrical in form, arranged radially around the gastral cavity, straight, not branched, terminating in low rounded distal cones.

The skeleton of the chamber layer is composed of the basal rays of subgastral triradiates and of tubar tri- and quadriradiates which are articulated in a few layers. The apical rays of the tubar quadriradiates project into the flagellated chamber. The distal ends of the flagellated chambers are provided with several triradiates with the basal rays pointing outwardly and with a tuft of oxea and hair-like spicules. The ordinary oxea are only four or five in number, while the hair-like spicules are more numerous.

The gastral skeleton is made up of paired rays of subgastral triradiates and of a single or two layers of gastral quadriradiates with their long apical rays projected into the gastral cavity. The basal rays of the gastral quadriradiates are mostly pointed towards the sponge base.

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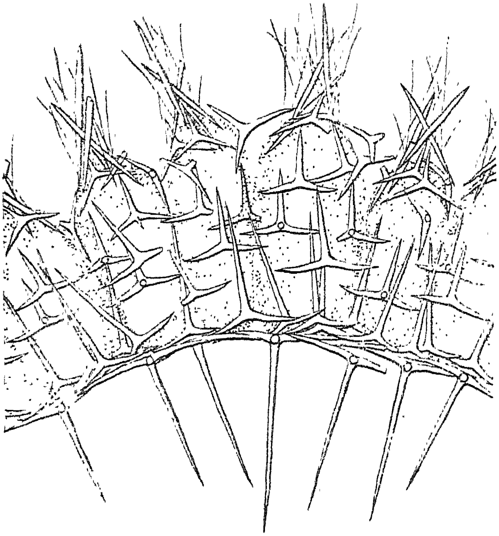
[1] *Sycandra ramsayi*, LENDENFELD, 1885, p. 1097, figs. 35–40.

[2] *Streptoconus australis*, JENKIN, 1908, p. 25, Pl. 27, fig. 3, Pl. 32, Pl. 33, figs. 75–80.

The oscular margin consists of linear spicules and of quadriradiates. The former kind of spicules occur in longitudinal disposition, while the latter are larger and stouter than any other radiates of other parts of the body with divergent paired rays and arranged densely in several rows forming a collar, pointing their basal rays downwards.



Text-fig. 12. *Sycon pulchrum*, n. sp. Part of a cross-section. ×100.

Spicules (Text-fig. 13):—Triradiates at the distal ends of flagellated chamber (a) slightly sagittal but equiradiates. Basal ray straight, while the paired rays curved forwards. Rays sharply pointed, and not placed in one plane, 90–100 μ long and about 10 μ thick at base.

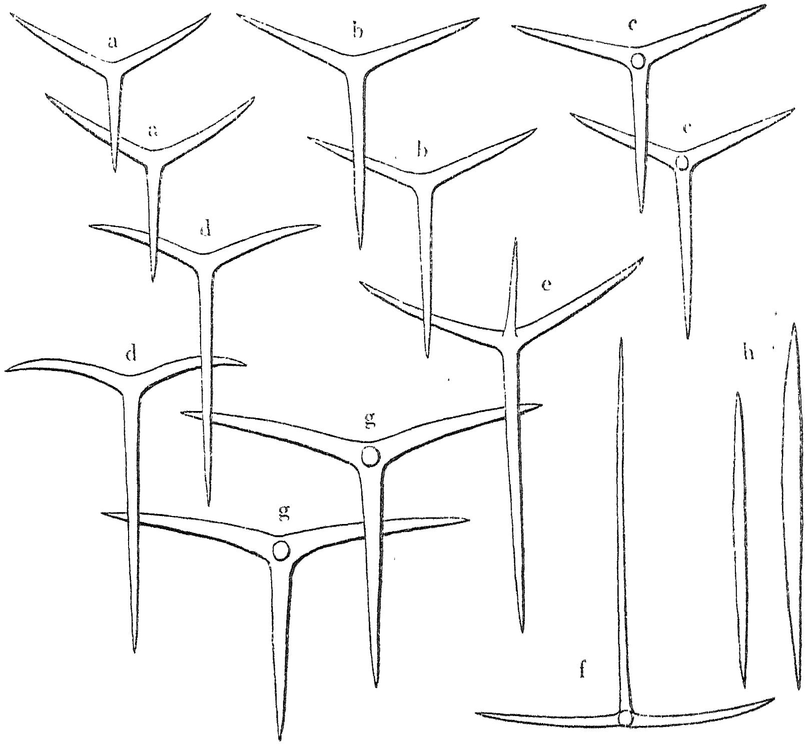
Tubar triradiates (b) strongly sagittal. Basal ray straight, tapering to the sharply pointed end, longer than paired rays, 110–140 μ long and 8–10 μ thick at base. Paired rays equal, widely divergent, 80–95 μ long and 8–10 μ thick at base.

Tubar quadriradiates (c) exactly similar to the tubar triradiates, differing only in the presence of apical ray. Apical ray short, sharply pointed, slightly curved upwards, about 50 μ long and 8 μ thick at base.

Subgastral triradiates (d) also strongly sagittal. Basal ray straight, tapering to sharp end, much longer than paired rays, 160–200 μ long and about 10 μ thick at base. Paired rays equal, curved backwards, 80–100 μ long and 10 μ thick at base.

Gastral quadriradiates (e, f) sagittal. Basal ray straight, longer than paired rays, 150–180 μ long and 10 μ thick at base. Paired rays nearly equal, sharply ended, 100–130 μ long and 10 μ thick at base. Apical ray very slender, nearly straight, variable in length, 140–250 μ long and 8–10 μ thick at base.

Quadriradiates of the oscular margin (g) sagittal. Basal ray straight, sharply pointed, slightly longer than paired rays, 130–160 μ long and 15–18 μ thick at base. Paired rays equal, widely divergent, 120–140 μ long and 15–18 μ thick at base. Apical ray slightly curved oralwards, sharply pointed, about 70 μ long and 10–15 μ thick at base.



Text-fig. 13. *Sycon pulchrum*, n. sp. a, tubar triradiates of the distal end of flagellated chambers; b, tubar triradiates; c, tubar quadriradiates; d, subgastral triradiates; e, gastral quadriradiate; f, same from lateral side; g, quadriradiates of oscular margin; h, oxea at the distal end of flagellated chambers. All × 210.

Oxea at the distal end of flagellated chamber (h) nearly straight, tapering to both sharply pointed ends, 180–210 μ long and about 10 μ thick in the middle part.

Hair-like spicules at the distal ends of flagellated chambers very fine, more or less curved, reaching a length over 400 μ by 2 μ thick.

Linear spicules of oscular margin straight, thicker than preceeding hair-like spicules, 270–380 μ long and about 4 μ thick.

Locality :— Off Kosikijima, Kagosima Prefecture, depth 100 fathoms.

Remarks :— It is very easy to distinguish the present species from the other members of the same genus by the following characteristics; 1) the presence of tubar quadriradiates, 2) long slender apical rays of gastral quadriradiates, and 3) the presence of stouter quadriradiates in the oscular margin.

54. Sycon raphanus O. SCHMIDT

Sycon raphanus, O. SCHMIDT, 1862, p. 14, Taf. 1, figs. 2 2d; 1864, p. 32; POLÉJAEFF, 1883, p. 40; TOPSENT, 1894, p. 37; DENDY, 1893, p. 80; BREITFUSS, 1896, p. 428; 1898, p. 17; p. 93; p. 110; p. 217; 1927, p. 29; LACKSCHEWITZ, 1886, p. 302; ROW, 1909, p. 185; DENDY and ROW, 1913, p. 748; HÔZAWA, 1929, p. 297; ROW and HÔZAWA, 1931, p. 769.

Grantia raphanus, GRAY, 1867, p. 554.

Sycarium vesica, HAECKEL, 1870, p. 238.

Sycandra raphanus, HAECKEL, 1872, p. 312, Taf. 53, fig. 4, Taf. 60, fig. 7; SCHULZE, 1875, p. 247, Taf. 18–21; LENDENFELD, 1885, p. 1093; 1892, p. 246.

Distribution:— Cosmopolitan: White Sea; Murman Coast; Barents Sea; Greenland; Bergen; Coast of Portugal: Tristan da Cunha; Minorca; Gulf of Gabes; Mediterranean Sea; Red Sea; Ceylon; Java; Gulf of St. Vincent; Port Phillip Heads; Bass Strait; King Island; Ternate; Philippine Island; Fremantle and Albany District. *In Japan*—Tôkyo Bay (HAECKEL).

55. Sycon rotundum TANITA

(Pl. XIV, figs. 42, 43)

Sycon rotundum, TANITA, 1941, pp. 270–273, Pl. 17, fig. 5, text-fig. 2; 1942, p. 36.

The collection contains a great number of specimens of this species which were obtained by Dr. SATÔ and by the present writer from various localities of Honsyû, Sikoku, and Kiusyû. They are closely similar to one another in appearance, but vary in length from 3.5 mm to 11 mm.

Each of them shows a solitary individual of a nearly spherical form and is provided with an osculum at the upper end which is surrounded by a well-developed collar.

The largest specimen (Pl. XIV, fig. 42) which came from Hirayama in Ehime Prefecture measures 11 mm in length and 7.5 mm in the greatest breadth. The dermal surface of the sponge is strongly hispid on account of the projecting oxea.

The colour of the specimens in alcohol is yellowish grey due to the contamination with mud.

With respect to the anatomical structure and spiculation, the specimens at hand are identical with the type.

Previously known Distribution:—Onagawa Bay; Misaki; Awa-Kominato (TANITA).

Localities:—Toba Bay; Hamajima, Mie Pref.; Kata, Wakayama Pref.; Mimase and Sukumo-Ôsima, Kôti Pref.; Hirayama and Yahatahama, Ehime Pref.; Hiuga-Utimi; Tomioka, Kumamoto Pref.; Senzaki, Yamaguti Pref.; Nezugaseki, Yamagata Pref.

Remarks:—This species was described for the first time by the writer, using the specimens obtained from Onagawa Bay. Afterwards, it was reported from Misaki and Awa-Kominato.

Judging from the distributions mentioned above, the present species seems to be one of the commonest *Sycon* in the Japanese waters.

56. **Sycon satsumensis** HÔZAWA

Sycon satsumensis, HÔZAWA, 1929, pp. 310–312, Pl. 4, figs. 24, 25, text-fig. 13.

Distribution:— Kagosima Bay (HÔZAWA).

57. **Sycon simushirensis** HÔZAWA

Sycon simushirensis, HÔZAWA, 1918, pp. 529–531, Pl. 84, fig. 6, text-fig. 2; 1929, p. 297; TANITA, 1941, p. 273.

Distribution:— Simushir Island (HÔZAWA); Onagawa Bay (TANITA).

58. **Sycon uragamii** TANITA

Sycon uragamii, TANITA, 1940, pp. 171–174, Pl. 8, fig. 5, text-fig. 3.

Distribution:— Matusima Bay (TANITA).

59. **Sycon yatsui** HÔZAWA

Sycon yatsui, HÔZAWA, 1929, pp. 297–300, Pl. 3, figs. 14, 15, text-fig. 8.

Distribution:— Misaki (HÔZAWA).

F. Family **Heteropiidae** DENDY

Diagnosis:— With a distinct and continuous dermal cortex covering over the chamber-layer and pierced by inhalant pores. Subgastral sagittal and subdermal pseudosagittal radiates are present. Flagellate chambers varying from elongated and radially arranged to spherical and irregularly scattered. With or without an articulate tubar skeleton. Nuclei of collared cells probably always apical.

Genus **Grantessa** LENDENFELD (1885) emend.

Diagnosis:— Canal system syconoid. No colossal longitudinally placed oxea.

60. **Grantessa nemurensis** HÔZAWA

Grantessa nemurensis, HÔZAWA, 1929, pp. 315–318, Pl. 5, figs. 28, 29, text-fig. 5; HÔZAWA and TANITA, 1941, p. 421, fig. 1.

Distribution:— Nemuro (HÔZAWA); Akkesi Bay (HÔZAWA and TANITA).

Remarks:— This species was first described by HÔZAWA, using two specimens obtained from Nemuro in Hokkaidô. Afterwards, it was reported by HÔZAWA and TANITA from Akkesi Bay. Thus the species seems to be found in the northern parts of Japan, being found hitherto in Hokkaidô.

This species may be easily distinguished from other members of the genus by the peculiar external features, by the club-shaped oxea, and by the gastral quadriradiates with long apical ray.

61. **Grantessa sagamiana** HÔZAWA

Grantessa sagamiana, HÔZAWA, 1916, pp. 8–14, Pl. 1, fig. 3, Pl. 2, fig. 12, text-fig. 2; 1929, p. 315.

Distribution:— Okinose; Sunosaki; Enoura, Suruga Bay (HÔZAWA).

62. **Grantessa shimeji** HÔZAWA

(Pl. XIV, fig. 44)

Grantessa shimeji, HÔZAWA, 1916, pp. 2–8, Pl. 1, figs. 1, 2, Pl. 2, figs. 10, 11, text-fig. 1; 1929, p. 315; TANITA, 1942, p. 40, Pl. 3, fig. 13.

Of this species only a single specimen contained in the collection was examined by the writer. It was secured from the oyster bed in Toba Bay in 1939. The sponge forms an irregular elongated small colony with a height of 41 mm. The colony consists of five erect and cylindrical tubes, each of these varying from 1.5 mm to 5 mm in diameter. The osculum at each upper end of the tubes is approximately circular in shape with a diameter of 1–2 mm. The dermal surface is slightly hispid owing to the projecting tufts of oxea. The colour of the sponge in alcohol is nearly white.

In anatomical structure and spiculation, the present specimen is identical with the type, so that there is no need to add any further descriptions.

Previously known Distribution:—Misaki (HÔZAWA, TANITA); Sima-Ôsima (HÔZAWA); Simoda (TANITA).

Locality:— Toba Bay, Mie Prefecture.

Remarks:— This species was first described by HÔZAWA in 1916, using several specimens obtained from Misaki and Sima-Ôsima. Afterwards, it was reported by the present writer as found in Izu Peninsula. This is the third report dealing with the occurrence of this species in the Japanese waters.

63. **Grantessa shimoda** TANITA

(Pl. XIV, figs. 45, 46)

Grantessa shimoda, TANITA, 1942, pp. 40-43, Pl. 3, fig. 14, text-fig. 7.

Seven specimens of this species exist in the collection, of which five were obtained from the oyster bed in Toba Bay, while the remaining two were secured in the neighbourhood of the Amakusa Marine Biological Station.

The first specimen (Pl. XIV, fig. 45) which came from Toba Bay is a small solitary individual of a nearly triangular form, more or less laterally compressed, broadest near the base and tapers towards the upper end. It measures 20 mm in length and 15 mm in the greatest breadth. The osculum at the extremity of the body is circular in shape with a diameter of 2.5 mm and is surrounded by a feebly developed oscular collar. The dermal surface is strongly hispid due to the projecting large oxea.

The second specimen (Pl. XIV, fig. 46) which was also obtained from Toba shows a cylindrical form with a height of 21.5 mm. Near the base of the sponge, there exists a round protuberance.

The specimens came from Amakusa are smaller in size, being 8–10 mm in length.

The colour in spirit is nearly white and the texture is rather firm.

Previously known Distribution:— Simoda Bay (TANITA).

Localities:— Toba Bay; Tomioka, Kumamoto Prefecture.

Remarks:— This species was described for the first time by the present writer, using a single specimen secured from Simoda Bay. This is, therefore, the second case that dealt with the occurrence of this form in the Japanese waters.

64. **Grantessa intusarticulata** (CARTER)

Hypograntia intusarticulata, CARTER, 1885–1886, p. 45.

Hypograntia medioarticulata, CARTER, 1885–1886, p. 46.

Grantessa intusarticulata, DENDY, 1892, p 108; 1893, p. 181, 201, Pl. 13, fig. 18; DENDY and ROW, 1913, p. 753; HÔZAWA, 1916, pp. 14–19, Pl. 1, fig. 4, Pl. 2, fig. 13, text-fig. 3; 1929, p. 318; 1933, p. 7; 1940, p. 37; BRØNDSTED, 1926, p. 308; ROW and HÔZAWA, 1931, p. 775; TANITA, 1942, p. 36, Pl. 2, fig. 10.

Grantia intusarticulata, BREITFUSS, 1897, p. 219.

Distribution:— Near Port Phillip Heads (CARTER, DENDY); Watson's Bay, Port Jackson (DENDY); Island Bay, Wellington, N. Z. (BRØNDSTED); Geraldton District, S. W. Australia (ROW and HÔZAWA). *In Japan* — Misaki (HÔZAWA, TANITA); Sunosaki; Wagu in Mie Pref.; Noto-Wajima (HÔZAWA); Kamakura; Simoda (TANITA).

Remarks:— This species was originally described in 1885 by CARTER under the name of *Hypograntia intusarticulata,* his descriptions being based on the materials taken from Australia. Since that time, it was reported from Australia and New Zealand by several investigators such as DENDY, BRØNDSTED, and ROW and HÔZAWA.

From the Japanese waters, the occurrence of this species was reported in 1916, 1933, and 1940 by HÔZAWA and in 1942 by the writer, dealing with the specimens obtained from several different localities. Judging from the distribution mentioned above, this species seems to be widely distributed in the world.

65. **Grantessa mitsukurii** HÔZAWA

(Pl. XV, figs. 47, 48)

Grantessa mitsukurii, HÔZAWA, 1916, pp. 23-27, Pl. 1, fig. 7, Pl. 2, fig. 15, text-fig. 5; 1929, p. 318; TANITA, 1942, p. 37, Pl. 2, fig. 11.

The collection contains twelve specimens of this species. Of the said twelve specimens, three were deposited in the Museum of the Seto Marine Biological Station, one was collected by Dr. SATÔ from Kannoura in Kôti Prefecture, three were obtained by the writer in the neighbourhood of the Amakusa Marine Biological Station, and the remaining four were secured from the shore of Izumo Kagamura.

Each of the spciemens represents an irregular colony, consisting of several strongly laterally compressed tubular individuals. Each individual is provided with an osculum at its upper end which is surrounded by a very feebly developed collar.

The largest specimen in the collection which came from Seto is 40 mm high and about 65 mm broad, but the edges of the colony are torn off.

The larger specimen which was collected in the neighbourhood of the Amakusa Marine Biological Station (Pl. XV, fig. 47) measures 28 mm in height and 36 mm in the greatest breadth and is provided with ten circular oscula.

The specimen came from Kannoura (Pl. XV, fig. 48) shows a rather massive colony with eight oscula, varying from 1.7 mm to 3.6 mm in diameter.

The colour in alcohol is dirty grey and the texture is rigid.

With respect to the canal system, skeletal arrangement, and spiculation, the present specimens are entirely identical with the descriptions of this species given by HÔZAWA.

Previously known Distribution:—Misaki (HÔZAWA); Tateyama; Awa-Kominato (TANITA).

Localities:—Tanabe Bay; Kannoura, Kôti Prefecture; Amakusa; Izumo-Kagamura, Simane Prefecture.

66. **Grantessa bifida**, n. sp.

(Pl. XV, fig. 49; Text-figs. 14, 15)

Three specimens upon which this new species was established exist in the collection, of which one was deposited in the Museum of the Seto Marine Biological Station, while the remaining two were obtained by Dr. SATÔ from Tatugusi in Kôti Prefecture.

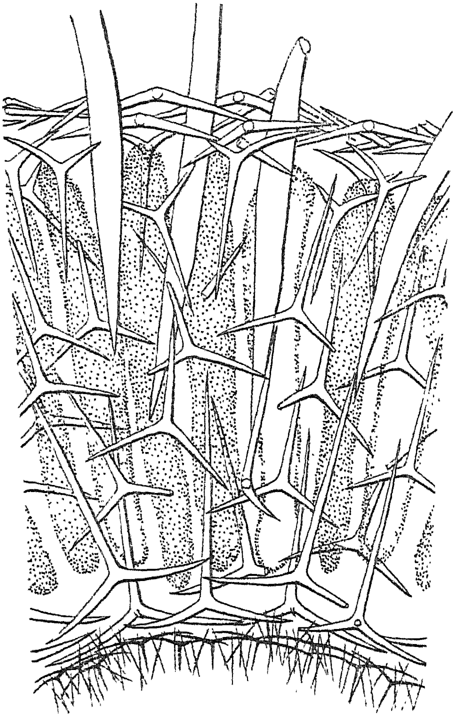
The largest specimen (Pl. XV, fig. 49) which came from Seto consists of two individuals, united together at their basal parts and attached to the substratum by the base directly. The total length of the sponge is 23 mm and the greatest breadth is 13 mm. Each individual represents an elongated cylindrical form, broadest near the base and tapering to the upper osculum which appears nearly naked. The oscula of both individuals are circular in shape with a diameter of 2.5 mm and of 1.3 mm respectively. The dermal surface of the sponge is highly hispid on account of the projecting oxea, while the gastral appears smooth to the naked eye. The wall is 1.5 mm thick in the middle parts of the body. The colour of the sponge in the preserved state is nearly white with faint yellowish tint and the texture is rather hard.

Structure (Text-fig. 14):—The canal system is typically syconoid. The flagellated chambers are arranged radially with regularity. They are straight, slender and are unbranched. They measure 100–180 μ in diameter at the broadest part.

The dermal skeleton is rather strongly developed, consisting of several layers of tangentially arranged dermal triradiates and of paired rays of subdermal pseudosagittal triradiates. Here and there occur large oxea which are deeply embedded in the sponge wall and project vertically from the surface to some extent.

The skeleton of the chamber layer is made up of the following elements: 1) the centripetal basal rays of subdermal pseudosagittal triradiates, 2) tubar triradiates, which are arranged in several rows and have their basal rays directed outwards, 3) the long centrifugal basal rays of subgastral tri- and quadriradiates, and 4) the proximal parts of large oxea.

The gastral skeleton is thinner than the dermal and is composed of paired rays of subgastral and tri- and quadriradiates and of tangentially placed gastral quadriradiates. The apical rays of gastral quadriradiates project into the gastral cavity. Microxea are fairly densely distributed in tangential disposition covering the gastral surface.



Text-fig. 14. *Grantessa bifida*, n. sp. Part of a cross-section. ×60.

The oscular margin has no special skeleton to be mentioned.

Spicules (Text-fig. 15):—Dermal triradiates (a) slightly sagittal. Basal ray straight, sharply pointed, 170–200 μ long and 15–18 μ thick at base. Paired rays equal, slightly curved forwards, longer than basal ray, 210–240 μ long and 15–18 μ thick at base.

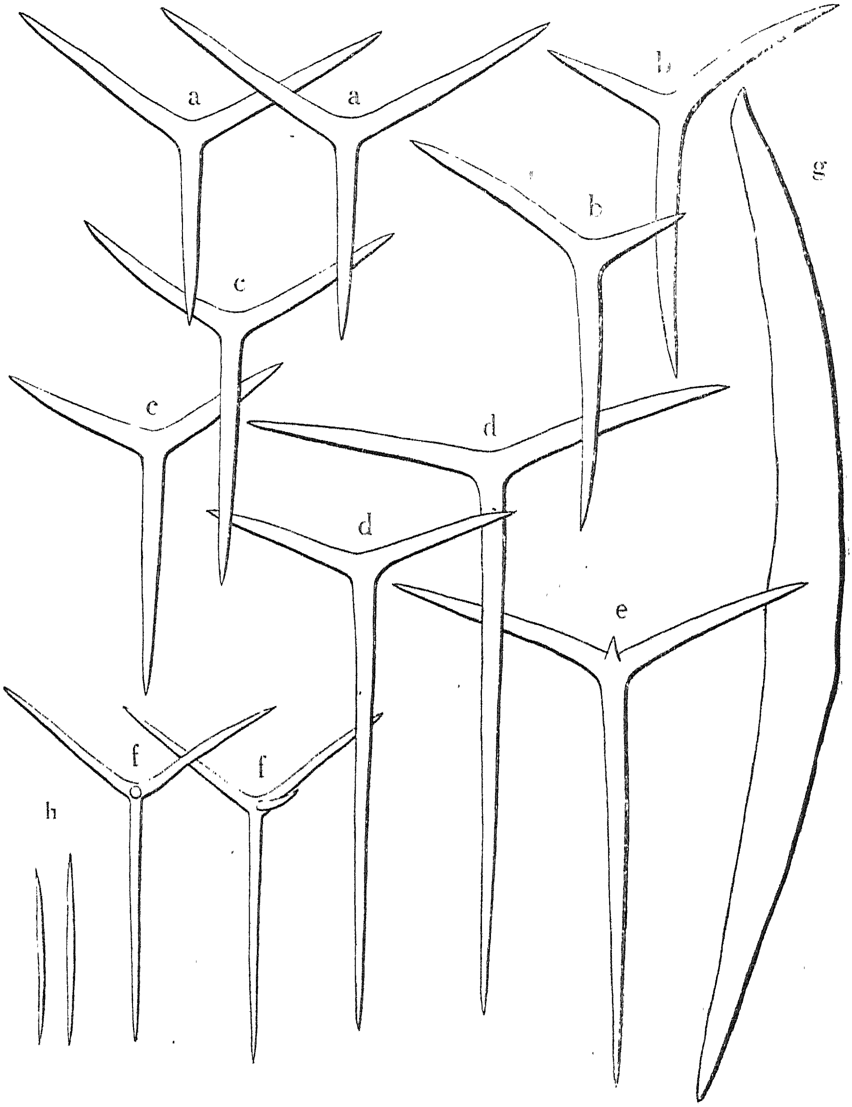
Subdermal triradiates (b) pseudosagittal with rays of different length. Basal ray nearly straightly or slightly curved, tapering to sharp end, longer than paired rays, 240–310 μ long and 16–20 μ thick at base. Paired rays are different in length. The longer ray always slightly curved backwards, 175–230 μ long and 16–20 μ thick at base. The shorter ray nearly straight, sharply pointed, 140–160 μ long and 16–20 μ thick at base.

Tubar triradiates (c) sagittal but all rays are equal in thickness being 18–25 μ. Basal ray straight, tapering to sharp point, longer than paired rays being 200–310 μ long. Paired rays equal, curved forwards being 170–230 μ long.

Subgastral triradiates (d) strongly sagittal, variable in size. Basal ray long, slender, sharply pointed, 420–610 μ long and 23–30 μ thick at base. Paired rays equal, widely divergent, curved backwards, 250–330 μ long and 23–30 μ thick at base.

Subgastral quadriradiates (e) similar to the triradiates of the same parts, except for the presence of short rudimental apical ray.

Gastral quadriradiates (f) strongly sagittal and rays are slender. Basal



Text-fig. 15. *Grantessa bifida*, n. sp. a, dermal triradiates; b, subdermal triradiates; c, tubar triradiates; d, subgastral triradiates; e, subgastral quadriradiate; f, gastral quadriradiates; g, large oxea; h, microxea. a–g × 120, h × 240.

ray straight, longer than paired rays, 200–270 μ long and about 10 μ thick at base. Paired rays equal, sharply pointed, 170–220 μ long and 10 μ thick at base. Apical ray curved oralwards, shorter and slightly thinner than the facial rays, about 80 μ long and 8 μ thick at base.

Large oxea (g) stout, elongate spindle shaped, sharply pointed at both ends, variable in length, 0.8–1.5 mm long and 35–85 μ thick in the thickest parts.

Microxea (h) straight, sharply pointed at both ends, nearly even in outline, 95–120 μ long and about 4 μ thick in the middle.

Localities :— Tosima, near Tanabe in Wakayama Prefecture; Tatugusi in Kôti Prefecture.

Remarks :— This new species is distinguished from most of the members of *Grantessa* by having both large oxea and microxea. Only five species which bear large and microxea have hitherto been recorded among the members of the genus *Grantessa*. But these species differ from the present species in lacking the gastral microxea. Namely, the main characteristic of this species is the presence of dense layer of microxea in gastral surface.

67. **Grantessa ampullae** HÔZAWA

Grantessa ampullae, HÔZAWA, 1940, pp. 38–40, Pl. 4, fig. 2, text-fig. 3.

Distribution :— Noto-Wajima, Isikawa Prefecture (HÔZAWA).

68. **Grantessa basipapillata** HÔZAWA

Grantessa basipapillata, HÔZAWA, 1916, pp. 19–23, Pl. 1, fig. 6, Pl. 2, fig. 14, text-fig. 4; 1929, p. 318.

Distribution :— Dôketsba, Sagami Sea (HÔZAWA).

69. **Grantessa parva** TANITA

(Pl. XV, fig. 50)

Grantessa parva, TANITA, 1942, pp. 38–40, Pl. 2, fig. 12, text-fig. 6.

Only a single specimen in the collection was assigned to this species. It was collected from a depth of about 20 fathoms in Owasi Bay by means of a coral-dredge.

The sponge (Pl. XV, fig. 50) shows an elongated oval form, more or less laterally compressed and is provided with a naked osculum at its upper end. It measures 6.5 mm in length and 4 mm in the greatest breadth and the wall is 0.5 mm thick in the middle parts of the body. The dermal surface is smooth and the colour in alcohol is white.

Previously known Distribution:— Misaki (TANITA).

Locality:— Owasi. Mie Prefecture, depth about 20 fathoms.

Remarks:— This species was first described by the writer in 1942, using a single specimen obtained from Misaki. This is the second record of this species as found in the Japanese waters.

Genus **Heteropia** CARTER (1885–1886) emend.

Diagnosis:— Canal system syconoid. Dermal cortex with colossal longitudinal oxea.

70. **Heteropia medioarticulata** HÔZAWA

Heteropia medioarticulata, HÔZAWA, 1918, pp. 531–534, Pl. 84, fig. 7, text-fig. 3; 1929, p. 319.

Distribution:— Off Cape Tonin; off Cape Patience, Saghalin (HÔZAWA).

71. **Heteropia striata** HÔZAWA

(Pl. XV, fig. 51)

Heteropia striata, HÔZAWA, 1916, pp. 28–33, Pl. 1, fig. 8, Pl. 2, fig. 16, text-fig. 6; 1929, p. 318; TANITA, 1942, p. 43, Pl. 3, fig. 15.

Numerous specimens of this species were collected from various localities. Each of the specimens represents an irregular colony consisting of several tubular individuals, united together at their bases. Each of the larger individuals, is provided with terminal osculum, surrounding by a feebly developed fringe, while the smaller are blind.

The largest specimen in the collection (Pl. XV, fig. 51) which was obtained from the pearl oyster bed in Ago Bay, shows an irregular massive colony with the height of 33 mm and the greatest breadth of about 40 mm. The tubular individuals are broadest at base and taper distally. The surface of the tubes shows a longitudinal striation owing to the presence of large oxea in dermal cortex. The colour in spirit is yellowish white and the texture is firm.

As the minute structure and the spiculation of this species were already fully described by HÔZAWA, there is no need to add any further descriptions.

Previously known Distribution:— Misaki (HÔZAWA, TANITA); Bôsyû Daibusa (TANITA).

Localities:— Toba Bay and Ago Bay, Mie Prefecture; Siohomisaki and Tanabe Bay, Wakayama Prefecture; Tatugusi, Kôti Prefecture; Amakusa-Tomioka, Kumamoto Prefecture; Hiuga-Hososima, Miyazaki Prefecture; Izumo-Kagamura, Simane Prefecture.

Remarks:— This species was described for the first time by HÔZAWA, the specimens being taken in the neighbourhood of the Misaki Marine Biological Station. Afterwards, it was reported by the writer from the same locality and from Bôsyû Daibusa. Thus the present species has been reported only from the Sagami Sea till the present collection. However, judging from the distributions mentioned above and from the number of specimens obtained, this form seems to be found very commonly in the adjacent seas of Japan.

Genus **Amphiute** HANITSCH (1894)

Diagnosis:— Canal system syconoid. Both gastral and dermal cortices with colossal longitudinal oxea.

72. **Amphiute ijimai** HÔZAWA

Amphiute ijimai, HÔZAWA, 1916, pp. 33-38, Pl. 1, fig. 9, Pl. 2, fig. 17, text-fig. 7; 1929, p. 319; 1933, p. 8, Pl. 1. fig. 4; TANITA, 1942, p. 44, Pl. 3, fig. 16.

Distribution:— Dôketsba in Sagami Sea. Senoumi in Suruga Bay (HÔZAWA); off Zyôgasima near Misaki (TANITA).

Genus **Vosmaeropsis** DENDY (1892)

Diagnosis:— Canal system sylleibid or leuconoid. Skeleton of the chamber layer composed of the centrifugally directed rays of subgastral sagittal triradiates and the centripetally directed rays of subdermal pseudosagittal triradiates, which may be supplemented or partially replaced by confused triradiates. No colossal longitudinal oxea.

73. **Vosmaeropsis japonica** HÔZAWA

Vosmaeropsis japonica, HÔZAWA, 1929, pp. 324-327, Pl. 6, figs. 34, 35, text-fig. 18; 1940, p. 143, Pl. 6, fig. 6; TANITA, 1942, p. 44, Pl. 3, fig. 17.

This species is represented by thirteen specimens in the collection. They were obtained by the writer from four different localities. All of them are nearly alike in appearance to each other, though vary from 4 mm to 13 mm in length.

Each of the specimens is a solitary individual of a nearly oval form and is provided with a circular osculum at its upper end. The dermal surface of the sponge is highly hispid on account of the projecting oxea.

The colour of the specimens is white with faint brownish tint and the texture is rather firm.

Previously known Distribution:—Misaki (Hôzawa, Tanita); Nakôzaki; Tateyama; Simoda (Tanita).

Localities:— Senzaki, Yamaguti Prefecture; Hamada and Izumo-Kaga-mura, Simane Prefecture; Wakasa-Takahama, Hukui Prefecture.

74. Vosmaeropsis grisea TANITA

(Pl. XV, fig. 52)

Vosmaeropsis griseus, Tanita, 1959, pp. 319–322, figs. 1, 2.

This species is represented by three specimens in the collection. They were collected by Dr. Taki and were deposited in the Museum of the Onomiti Marine Biological Station. The specimens are all alike in appearance.

The largest specimen (Pl. XV, fig. 52) represents an elongated cylindrical form, broadest near the base and tapers towards the top. It is 17 mm long and 4 mm broad at the broadest parts. The osculum at the upper end is provided with a feebly developed collar and leads into a rather narrow gastral cavity extending throughout the entire length of the sponge. The outer surface of the body is highly hispid from the projecting oxea.

The colour in alcohol is nearly white with faint greyish tint.

Previously known Distribution:— Saseho, Nagasaki Prefecture (Tanita).

Locality:— Onomiti, Okayama Prefecture.

Remarks:— The present species was first described by the writer, using two specimens obtained from Saseho. This is, therefore, the second report that dealt with the occurrence of this species in the Japanese waters.

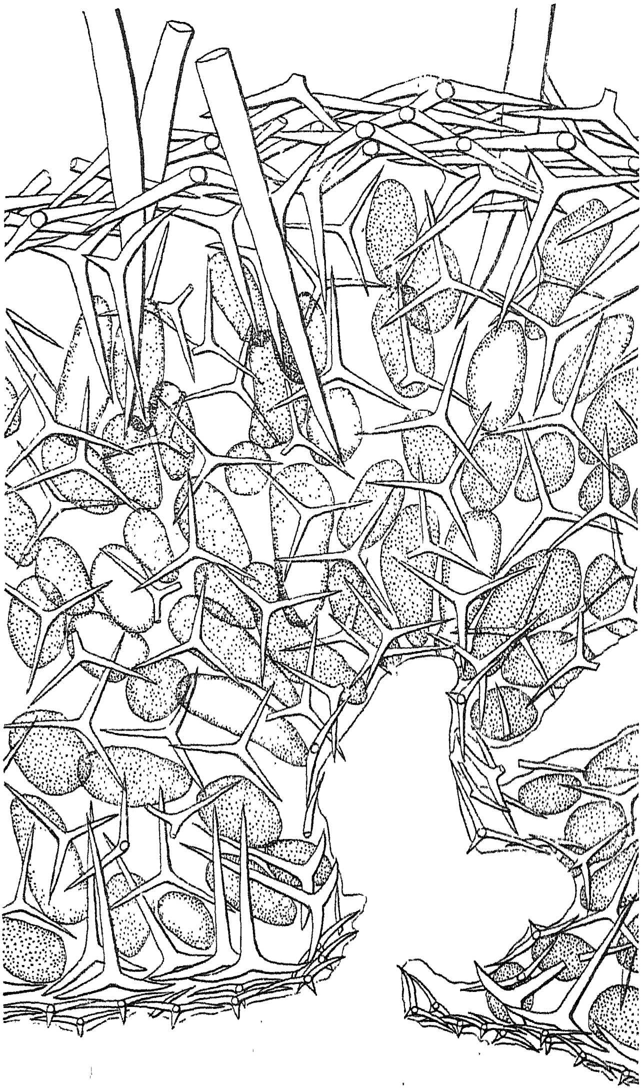
75. Vosmaeropsis spinosa, n. sp.

(Pl. XV, fig. 53; Text-figs. 16, 17)

There are four specimens of this new species in the collection. They were obtained by the writer himself in the neighbourhood of the Amakusa Marine Biological Station.

The largest specimen (Pl. XV, fig. 53) which I have selected as the type consists of two individuals of laterally compressed oval form, uniting together at their bases. The total length of the sponge is 9 mm and the greatest breadth is 12 mm. The osculum at the upper end of the individual is nearly circular with a diameter of about 1 mm and is surrounded by a feebly developed collar. The dermal surface is strongly hispid due to the projecting large oxea, while the gastral appears smooth and is perforated by circular exhalant apertures with a diameter of 0.5 mm. The body wall measures 3 mm in thickness at the middle parts of the body. The colour in spirit is white and the texture is hard.

The remaining specimens represent a solitary person of nearly spherical



Text-fig. 16. *Vosmaeropsis spinosa*, n. sp. Part of a cross-section. ×60.

from and vary from 5 mm to 8 mm in length.

Structure (Text-fig. 16):— The canal system of this species is of the intermediate between sylleibid and leuconoid type. The flagellated chambers found near the larger exhalant canals are of elongated sac-like configuration and are arranged radially, while those situated in the middle parts of the body wall are of oval shape.

The skeleton of the dermal cortex is relatively thick, being composed of a few layers of tangentially placed dermal triradiates, of paired rays of subdermal pseudosagittal triradiates, and of large oxea. The large oxea which occur sparsely in the sponge wall project from the dermal surface making nearly right angles with it, but with the approach to the osculum these spicules have a tendency to be placed obliquely.

The skeleton of the chamber layer is made up of the following elements: 1) centripetal basal rays of subdermal pseudosagittal triradiates, 2) tubar triradiates which are irregularly and thickly packed between the dermal and the gastral cortices, 3) centrifugal basal rays of subgastral tri- and quadriradiates, and 4) the proximal parts of large oxea.

Gastral skeleton is thinner than the dermal and consists of the paired rays of subgastral tri- and quadriradiates and of facial rays of gastral quadriradiates which are tangentially placed with their apical ray pointing towards the gastral cavity.

The skeleton of the oscular margin is composed of linear spicules and of quadriradiates with wide oral angles. The former kind of spicules run parallel to the basal rays of the latter.

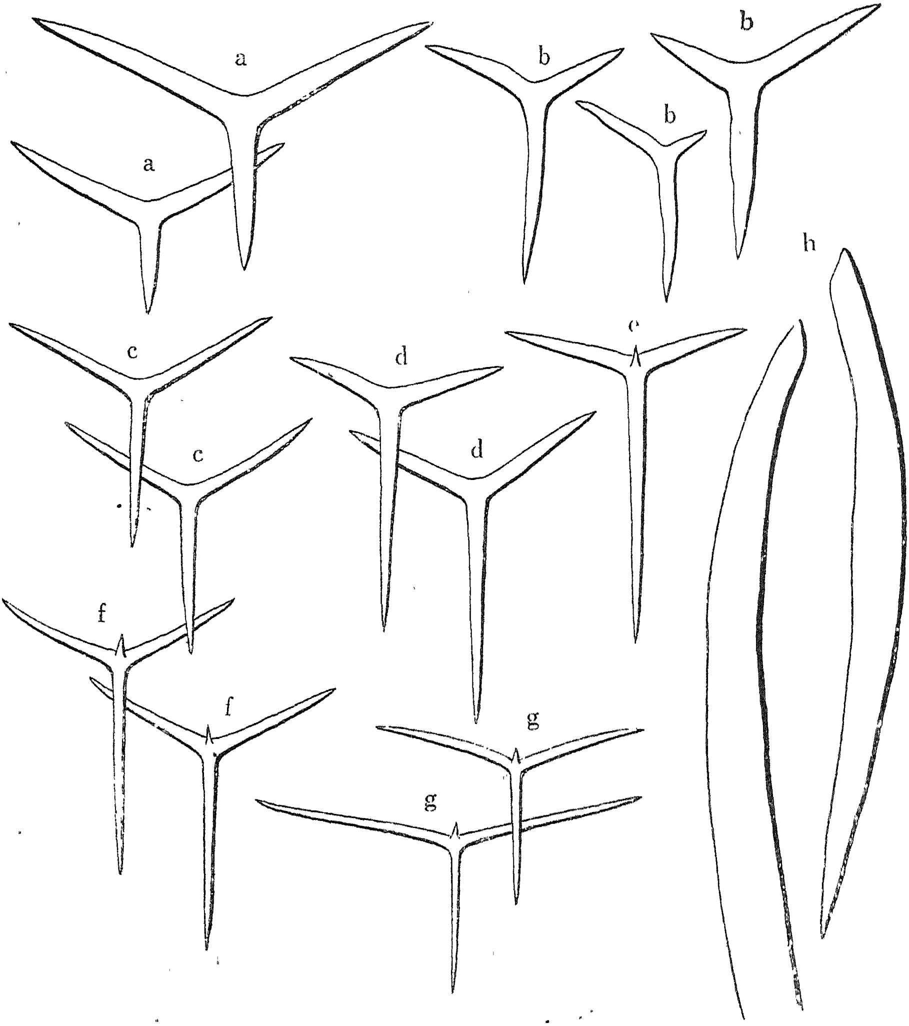
Spicules (Text-fig. 17):— Dermal triradiates (a) sagittal. Basal ray straight, tapering to sharp point, shorter than paired rays, 140–210 μ long and 26–32 μ thick at base. Paired rays nearly equal, either straight or very slightly curved forwards, 210–280 μ long and 26–32 μ thick at base.

Subdermal triradiates (b) pseudosagittal. All rays are of different length but are nearly equally thick being 28–33 μ. Basal ray nearly straight, but is undulated in outline, sharply pointed, longer than paired rays being 230–330 μ. The longer paired ray usually doubly curved, sharply ended, being 190–220 μ in length. The shorter paired ray nearly straight, tapering towards sharp point being 140–160 μ in length.

Tubar triradiates (c) slightly sagittal and rays are slender than those of the dermal triradiates. Basal ray straight, longer than paired rays, 200–260 μ long and 15–20 μ thick at base. Paired rays equal, nearly straight, 180–220 μ long and 15–20 μ thick at base.

Subgastral triradiates (d) strongly sagittal and rays are as thick as the dermal. Basal ray straight, tapering to sharply pointed end, much longer than paired rays, 300–370 μ long and 20–30 μ thick at base. Paired rays equal, slightly curved backwards, widely divergent, 140–220 μ long and 20–30 μ thick at base.

Subgastral quadriradiates (e) exactly similar to subgastral triradiates, except for the presence of short apical ray. Apical ray straight, much



Text-fig. 17. *Vosmaeropsis.spinosa,* n. sp. a, dermal triradiates; b, subdermal triradiates; c, tubar triradiates; d, subgastral triradiates; e, subgastral quadriradiates; f, gastral quadriradiates; g, quadriradiates of oscular margin; g, large oxea. All × 100.

shorter and thinner than facial rays, about 60 μ long and 14 μ thick at base.

Gastral quadriradiates (f) strongly sagittal. Basal ray straight, sharply pointed, 270–330 μ long and 10–15 μ thick at base. Paired rays nearly equal, slightly curved forwards, shorter than basal ray, 140–220 μ long and 10–15 μ thick at base. Apical ray curved oralwards, sharply ended, shorter and thinner than facial rays, 65–90 μ long and about 10 μ thick at base.

Quadriradiates of oscular margin (g) strongly sagittal. Basal ray straight, sharply pointed, thinner than paired rays, 150–210 μ long and about 8 μ thick at base. Paired rays equal, nearly straight, widely divergent, 200–260 μ long and 10–13 μ thick at base. Apical ray short, curved upwards, sharply pointed, about 75 μ long and 8 μ thick at base.

Large oxea (h) elongated spindle-shape, more or less curved, thickest in the middle parts, tapering to sharply pointed proximal end, while the distal end rather bluntly pointed, 1–1.8 mm long and 60–80 μ thick in the middle parts.

Locality:— Tomioka, Kumamoto Prefecture.

Remarks:— This species bears a close resemblance in external features to *Vosmaeropsis japonica* HÔZAWA[1], but it may be easily distinguished from the latter by the absence of microxea and by the canal system.

76. **Vosmaeropsis maculata** HÔZAWA

(Pl. XVI, figs. 54, 55)

Vosmaeropsis maculata, HÔZAWA, 1929, pp. 321–324, Pl. 5, figs. 32, 33, text-fig. 17; TANITA, 1941, p. 273, Pl. 17, fig. 6; 1942, p. 45, Pl. 3, fig. 18.

A great number of specimens of this species exist in the collection, which were obtained from various localities stretching from Okinawa to Kii Peninsula.

They vary both in shape and size considerably. The sponge represents either oval, pear-shape, or elongated tubular form, ranging from 5 mm to about 35 mm in length.

Each of them is provided with a naked osculum at the upper end which is circular or irregular in shape. The dermal surface is smooth but is not quite even.

With regard to the canal system, the skeletal arrangement, spicules, etc., these specimens at hand seem to agree well with the type.

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1) *Vosmaeropsis japonica* HÔZAWA, 1929, pp. 324–327, Pl. 6, figs. 34, 35, text-fig. 18.

Previously known Distribution:— Misaki (HÔZAWA, TANITA); Enoura in Suruga Bay (HÔZAWA); Onagawa Bay; Awa-Kominato; Simoda (TANITA).

Localities:— Toba Bay; Iyo-Takahama; Hiuga-Hososima; Amakusa; Mogi, Nagasaki Prefecture; Hamada and Izumo-Kagamura, Simane Prefecture; Wakasa-Takahama, Hukui Prefecture; Naha, Okinawa Prefecture.

Remarks:— The present species has been reported three times by HÔZAWA and by the writer before the present collections, as being found in the seas of Kantô and Tôhoku districts. Judging from the distributions and the number of specimens obtained, this species seems to be one of the most common Calcarea to be met with on the coasts of Japan.

77. **Vosmaeropsis sasakii** HÔZAWA

Vosmaeropsis sasakii, HÔZAWA, 1929, pp. 319–321, Pl. 5, figs. 30, 31, text-fig. 16.

Distribution:— Hakodate, depth 42.9 meters (HÔZAWA).

G. Family **Grantiidae** DENDY

Diagnosis:— With a distinct dermal cortex and a proper cortical skeleton of tangential radiates, sometimes supplemented by, and occasionally replaced by oxea. Flagellate chambers ranging from elongated and radially arranged to small, spherical and irregularly scattered. Skeleton of the chamber layer ranging from regularly articulate to irregularly scattered. Typically with subgastral sagittal radiates. No subdermal pseudosagittal triradiates. Subdermal quadriradiates, if present, always associated with a chamber-layer skeleton containing confused triradiates. Nuclei of collared cells probably always apical.

Genus **Grantia** FLEMING (1828) emend.

Diagnosis:— Canal system syconoid. Colossal longitudinal oxea, if present, projecting from the surface. Tubar skeleton articulate, composed of radiate spicules, which may or may not be supplemented by oxea.

78. **Grantia harai** HÔZAWA

Grantia harai, HÔZAWA, 1929, pp. 328–331, Pl. 6, figs. 36, 37, text-fig. 19.

Distribution:— Kagosima Bay, depth of 100 meters (HÔZAWA).

79. **Grantia kujiensis** HÔZAWA

Grantia kujiensis, HÔZAWA, 1933, pp. 12–15, Pl. 1, fig. 6, text-fig. 3.

Distribution:— Off Kuji, Iwate Prefecture, depth 150 meters (HÔZAWA).

80. Grantia nipponica Hôzawa

Grantia nipponica, Hôzawa, 1918, pp. 584–587, Pl. 84, fig. 8, text-fig. 4; 1929, p. 328.

Distribution:— Off Nosaki, Notojima; off Cape Rollin, Simushir Island (Hôzawa).

81. Grantia uchidai Hôzawa and Tanita

Grantia uchidai, Hôzawa and Tanita, 1941, pp. 422–426, text-figs. 2–4.

Distribution:— Akkesi Bay (Hôzawa and Tanita).

Remarks:— This species was described for the first time by Hôzawa and Tanita in 1941, using three specimens obtained from Akkesi Bay. The most conspicuous feature of this species exists in the structure of the gastral skeleton forming many bridge-like conjunctions.

82. Grantia cupla (Haeckel)

Sycetta cupla, Haeckel, 1872, pp. 243–245, Pl. 42, figs. 9–12.
Grantia cupla, Dandy and Row, 1913, p. 761; Hôzawa, 1929, p. 334.

Distribution:— Japan (Haeckel).

83. Grantia glabra Hôzawa

Grantia glabra, Hôzawa, 1933, pp. 9–12, Pl. 1, fig. 5, text-fig. 2.

Distribution:— Off Tutiyazaki, Ugo, depth 150 meters; off Sioyazaki, Iwaki, depth 161 meters (Hôzawa).

84. Grantia stylata Hôzawa

Grantia stylata, Hôzawa, 1929, pp. 331–334, Pl. 6, figs. 38, 39, text-fig. 20.

Distribution:— Kagosima Bay (Hôzawa).

Genus Paragrantia Hôzawa (1940)

Diagnosis:— Canal system syconoid. Sponge usually a simple branched colony. Tubar skeleton articulate, composed of radiate spicules, which may or may not be supplemented by oxea. Around each apopyle of the flagellated chamber there exists a special skeleton composed of proper radiates.

85. Paragrantia waguensis Hôzawa

Paragrantia waguensis, Hôzawa, 1940, pp. 40–43, Pl. 5, figs. 8–11, text-fig. 4.

Distribution:— Wagu, Mie Prefecture (HÔZAWA).

Remarks:— This species is the type of the genus *Paragrantia* which was established by HÔZAWA in 1940. The most peculiar feature of this species is the presence of a special apopyle skeleton which is consisted of proper quadriradiates. Apical ray of the apopyle quadriradiates of this species looks like a frame of torch.

Genus **Ute** O. SCHMIDT (1862) emend.

Diagnosis:— Canal system syconoid. Tubar skeleton articulate. Dermal cortex well developed, containing colossal longitudinal oxea. No tufts of oxea at the distal ends of the flagellate chambers.

86. **Ute armata** HÔZAWA

(Pl. XVI, fig. 56)

Ute armata, HÔZAWA, 1929, pp. 337-339, Pl. 7, figs. 42, 43, text-fig. 22.

A single specimen (Pl. XVI, fig. 56) in the collection was assigned to this species. It was collected by means of a coral-dredge from a depth of 100 fathoms off Kosikijima in Kagosima Prefecture.

The sponge is a nearly circular in form, attached by the base to the substratum directly and shows a slit-like osculum at the upper end of the body. The total length is only 5 mm and the diameter is 2.5 mm. The dermal surface shows longitudinal striations owing to the presence of large oxea in the dermal cortex, but the lower portion of the body looks like a bush on account of numerous projecting large oxea.

The colour of the specimen in the preserved state is pure white and the texture is firm.

Previously known Distribution:— Sagami Sea, depth 286 meters (HÔZAWA).

Locality:— Off Kosikijima in Kagosima Prefecture, depth 100 fathoms.

Remarks:— This is the second report informing the occurrence of this species which was first described by HÔZAWA (1929). using the specimen taken from the Sagami Sea. The type specimen, as described by HÔZAWA, was secured from a depth of 286 meters in the Sagami Sea, and the present specimen was obtained from a depth of 100 fathoms, and thus this species seems probably to be found only in the deep sea.

87. **Ute pedunculata** HÔZAWA

Ute pedunculata, HÔZAWA, 1929, pp. 334–337, Pl. 6, figs. 40, 41, text-fig. 21; TANITA, 1942,

p. 45, Pl. 3, fig. 19.

Distribution:— Sagami Sea, depth 114 meters (HÔZAWA); Yodomi in Sagami Sea, depth 100 fathoms (TANITA).

Genus **Achramorpha** JENKIN (1908) emend.

Diagnosis:— Canal system syconoid. Skeleton of the chamber layer reduced to the basal rays of the subgastral sagittal triradiates (which may become quadriradiates by the addition of an apical ray), with radial oxea lying between the chambers and projecting from the surface. No colossal longitudinal oxea.

88. **Achramorpha diomediae** HÔZAWA

Achramorpha diomediae, HÔZAWA, 1918, pp. 540–542, Pl. 85, fig. 10, text-fig. 6; 1929, p. 340.

Distribution:— Off Cape Rollin, Simushir Islands (HÔZAWA).

Genus **Anamixilla** POLÉJAEFF (1883)

Diagnosis:— Canal system syconoid. Tubar skeleton reduced to the outwardly directed basal rays of the subgastral sagittal radiates. Skeleton of the chamber layer otherwise consisting of large triradiate spicules, arranged without regard to the direction of the chambers. Dermal cortex well developed, but without colossal longitudinal oxea.

89. **Anamixilla torresi** POLÉJAEFF

(Pl. XVI, figs. 57, 58)

Anamixilla torresi, POLÉJAEFF, 1883, pp. 50–51, Pl. 4, figs. 2a–2c; LENDENFELD, 1885, p. 1109; DENDY and ROW, 1913, p. 766; BURTON, 1930, p. 5, text-fig. 4.

This species is represented by two colonial and three solitary specimens in the collection. They were obtained by Dr. SATÔ from Palao in the Caroline Islands.

The largest specimen (Pl. XVI, fig. 57) is a colony of three tubular individuals, connected together at their basal parts. Two individuals are provided with a naked and circular osculum at each apex while the remaining one is blind. The total length of the colony is 20 mm and the breadth is 22 mm. The dermal surface is not smooth and the gastral seems to be slightly hispid on account of the projecting apical rays of gastral quadriradiates. The gastral cavity is very large and extends throughout the entire length of the body. The body wall is relatively thin, being only 1 mm in thickness.

The colour in the preserved state varies from nearly white to yellowish white and the texture is rather brittle.

Previously known Distribution:—Torres Strait, Australia (POLÉJAEFF); Amboina, Samau Island (BURTON), depth 3–23 fathoms.

Locality:—Palao, Caroline Islands.

Remarks:—This species was first described by POLÉJAEFF in 1883, using a single specimen obtained by the Challenger Expedition from Australia. In the same report, he established the genus *Anamixilla*, basing the description upon this species. After that time, this species was recorded by BURTON (1930) from Amboina and Samau Island, using the materials obtained by the Siboga Expedition. This is, therefore, the third record of this species.

Genus **Leucandra** HAECKEL (1872) emend.

Diagnosis:—Sponge usually a single person, or a colony of such persons in which the component individuals are readily recognisable. Canal system leuconoid. Skeleton of the chamber layer more or less confused, but frequently with vestiges of an articulate tubar skeleton in the form of subgastral or other sagittal triradiates. Dermal skeleton of tangentially placed triradiates, which may sometimes develop an apical ray. Colossal longitudinally placed oxea, when occuring in the dermal cortex, never forming a smooth layer, but always projecting conspicuously from the surface.

90. **Leucandra hozawai** TANITA

(Pl. XVI, figs. 59, 60)

Leucandra hozawai, TANITA, 1942, pp. 48–50, Pl. 4, fig. 22, text-fig. 8.

Many specimens in the collection have been assigned to this species. Of which, one was secured by Dr. IMAI from a depth of about 10 fathoms in Onagawa Bay, three were collected by Dr. SATÔ from Kamikawaguti, a province of Tosa, two were obtained by the writer from Tanabe Bay, and the remaining ones were obtained by the writer from the pearl oyster bed in Ago Bay.

They vary considerably both in shape and size, being either solitary or colonial.

The specimen came from Onagawa Bay (Pl. XVI, fig. 59) represents a solitary person, attached by the base to the substrutum. It is 11 mm in length and 16 mm in the greatest breadth. At the upper end of the body, there exists an osculum which is nearly naked and is circular in shape with a diameter of 3.5 mm. The dermal surface is highly hispid owing to the projecting large oxea. The colour in alcohol is white and the texture is hard.

The largest specimen (Pl. XVI, fig. 60) which was collected from the pearl oyster bed in Ago Bay, shows a colony of an irregular shape, being composed of several tubular individuals. The total length of the colony is 50 mm and the greatest breadth is 55 mm. The dermal surface of the sponge is uneven and is hispid on account of the projecting oxea. The colour of this sponge is pale yellowish brown and the texture is rather elastic.

The remaining specimens are irregular in form, and their colour varies from nearly white to yellowish brown.

With regard to the canal system, the internal structure, and the spicules, these specimens are similar to each other and seem to agree well with the type specimens of this species.

Previously known Distribution:— Misaki (TANITA).

Localties:—Onagawa Bay; Ago Bay; Tanabe Bay; Tosa-Kamikawaguti.

Remarks:— This species was first described by the present writer in 1942, using a single specimen obtained from Misaki. This paper, therefore, informs the occurrence of this species in the Japanese waters for the second time.

91. **Leucandra kagoshimensis** HÔZAWA

Leucandra kagoshimensis, HÔZAWA, 1929, pp. 344–347, Pl. 7, figs. 46, 47, text-fig. 24.

Distribution:— Kagosima Bay (HÔZAWA).

92. **Leucandra kurilensis** HÔZAWA

Leucandra kurilensis, HÔZAWA, 1918, pp. 549-551, Pl. 85, fig. 11, text-fig. 10; 1929, p. 342.

Distribution:— Off Cape Rollin, Simushir Island (HÔZAWA).

93. **Leucandra magna** TANITA

Leucandra magna, TANITA, 1942, pp. 53–55, Pl. 4, fig. 24, text-fig. 10.

Distribution:— Bôsyû Daibusa, depth 100–200 fathoms (TANITA).

Remarks:— The skeleton of this species is composed of triradiates and of oxea, lacking quadriradiates. By this characteristic, it may be easily distinguished from other members of the same genus.

94. **Leucandra odawarensis** HÔZAWA

Leucandra odawarensis, HÔZAWA, 1929, pp. 347–350, Pl. 8, figs. 48, 49, text-fig. 25.

Distribution:— Off Odawara, Sagami Sea, depth 172 meters (HÔZAWA).

95. **Leucandra tomentosa** TANITA

Leucandra tomentosa, TANITA, 1940, pp. 174–176, Pl. 8, fig. 6, text-fig. 4; 1941, p. 3, Pl. 1, fig. 4; p. 274.

Distribution:— Matusima Bay; Mutu Bay; Onagawa Bay (TANITA).

96. **Leucandra tropica**, n. sp.

(Pl. XVII, figs. 61, 62; Text-figs. 18, 19)

This new species is represented in the collection by five specimens. Of which, three were obtained by Dr. ABE in 1935, while the remaining two were collected by Mr. HIRO in 1936 from Palao.

The largest specimen (Pl. XVII, fig. 61) which is taken for the type, shows a solitary individual of an oval form, more or less laterally compressed and is provided with an osculum at the upper end. The sponge measures 17 mm in height and 20 mm in the greatest breadth. The osculum is of an irregular shape and is surrounded by a feebly developed collar. The dermal surface is uneven and is slightly hispid owing to the projecting oxea. The gastral cavity is comparatively large and the gastral surface is perforated by numerous circular exhalant apertures with diameters varying from 0.4 mm to 1.3 mm. The body wall is 3.5 mm thick in the thickest parts. The colour in the preserved state is yellowish white and the texture is rigid and brittle.

The remaining four specimens vary both in shape and in size. They are either oval or cylindrical in form and vary from 6 mm to 13 mm in length. Of these specimens, the one is shown in Pl. XVII, fig. 62.

Structure (Text-fig. 18):—The canal system is typically leuconoid. The flagellated chambers are of oval shape with maximum diameter of 100–145 μ and are scattered in the chamber layer without any order.

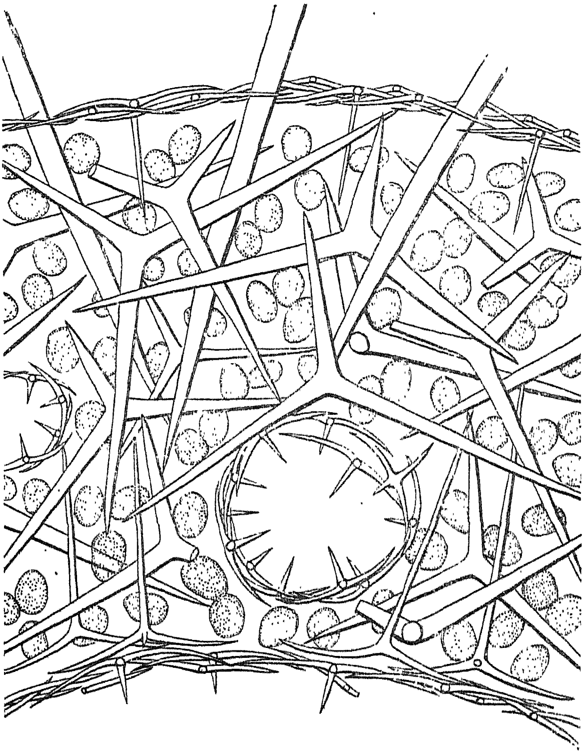
The dermal skeleton is very thin, consisting of two or three layers of tangentially placed dermal triradiates. Among these triradiates, there occur some number of dermal quadriradiates with facial rays parallel to the dermal surface and apical rays project into the mesoderm. Here and there, large oxea project from the dermal surface to some extent being their proximal parts implanted deeply in the chamber layer.

The skeleton of the chamber layer is composed of large sagittal tubar triradiates and of basal rays of subgastral tri- and quadriradiates. The inner parts of large oxea may be added to the skeleton. The tubar triradiates are closely set together and thus make the main parts of the skeleton.

The larger exhalant canals are provided with quadriradiates.

The skeleton of the gastral cortex is as thin as the dermal, consisting of a few layers of gastral tri- and quadriradiates which are placed tangentially. Beneath these radiates lie the paired rays of subgastral tri- and quadriradiates.

The skeleton of the oscular margin is a continuation of the gastral, composed of the same kinds of gastral radiates with wider oral angles. Linear spicules are added in longitudinal disposition to the skeleton.



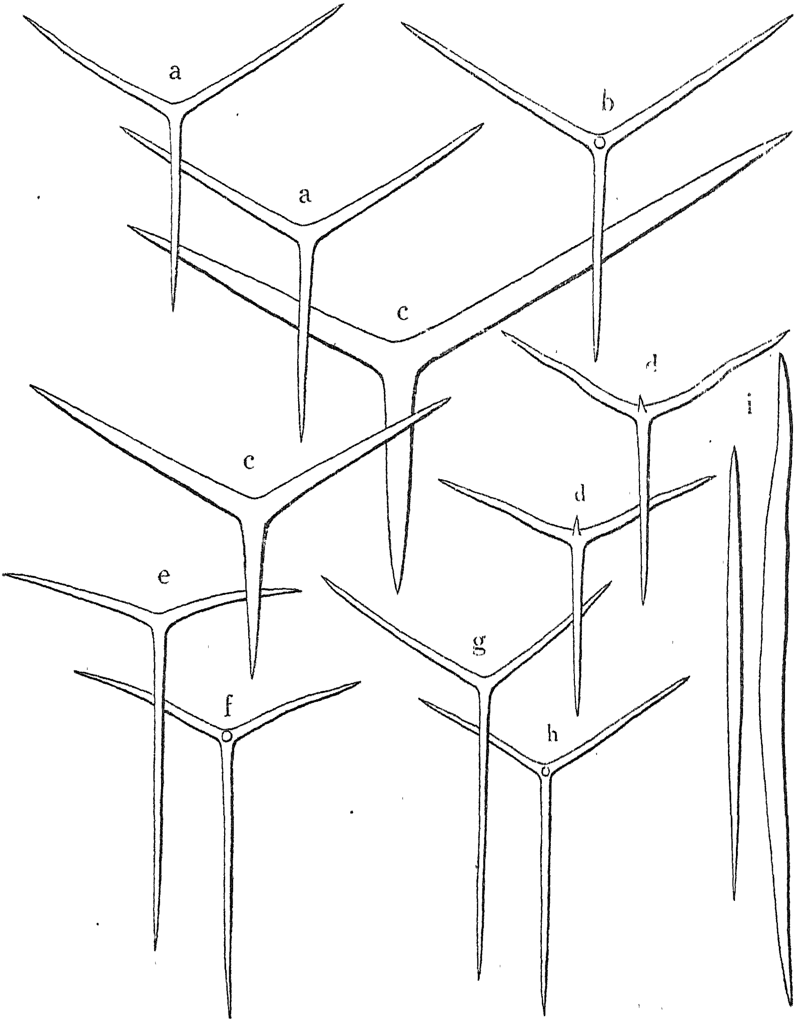
Text-fig. 18. *Leucandra tropica*, n. sp. Part of a cross-section. ×60.

Spicules (Text-fig. 19):— Dermal triradiates (a) slightly sagittal. Basal ray straight, sharply pointed, slightly shorter than paired rays, 250–330 μ long and 14–18 μ thick at base. Paired rays nearly equal, tapering towards sharp end, 280–380 μ long and 14–18 μ thick at base.

Dermal quadriradiates (b) nearly similar to the triradiates of the same, only differing in the presence of apical ray. Apical ray straight, finely pointed, shorter and thinner than facial rays, 230–260 μ long and about 12 μ thick at base.

Tubar triradiates (c) sagittal. All rays stout and equally thick being 45–60 μ at base. Basal ray straight, tapering towards sharply pointed end, much shorter than paired rays being 340–480 μ. Paired rays either nearly equal or unequal, straight and 640–800 μ long.

Quadriradiates of larger exhalant canals (d) sagittal and the facial rays are not in one plane. Basal ray straight, sharply pointed, longer than paired rays, 270–340 μ long and 12–15 μ thick at base. Paired rays



Text-fig. 19. *Leucandra tropica*, n. sp. a, dermal triradiates; b, dermal quadriradiate; c, tubar triradiates; d, quadriradiates of larger exhalant canal; e, subgastral triradiate; f, subgastral quadriradiate; g, gastral triradiate; h, gastral quadriradiate; i, large oxea. All × 90.

equal, slightly undulated, 220–300 μ long and 12–15 μ thick at base. Apical ray short, finely pointed, shorter and thinner than facial rays, about 160 μ long and 10 μ thick at base.

Subgastral triradiates (e) strongly sagittal. Basal ray straight, fairly sharply ended, much longer than paired rays, 450–600 μ long and 15–23 μ thick at base. Paired rays either equal, curved backwards, widely divergent, 280–320 μ long and 15–23 μ thick at base.

Subgastral quadriradiates (f) exactly similar to the triradiates of the same, only differing in the presence of rudimental apical ray.

Gastral triradiates (g) strongly sagittal. All rays are very slender with equal thickness of 10–12 μ. Basal ray straight, sharply ended, longer than paired rays being 370–450 μ long. Paired rays either equal or slightly unequal, nearly straight and 260–300 μ long.

Gastral quadriradiates (h) like the gastral triradiates, except for the presence of apical ray. Apical ray curved oralwards, fairly finely pointed, shorter than facial rays, 110–150 μ long and about 10 μ thick at base.

Large oxea (i) spindle-shaped, tapering towards both sharply pointed ends, and are variable in length, 800 μ–1.5 mm long and 45–65 μ thick in the thickest parts.

Locality :— Palao, Caroline Islands.

Remarks :— The main characteristic of this species is the presence of dermal quadriradiates with apical rays protruding not very deeply into chamber layer. In this point, the present species bears a close resemlance to *Leucandra thulakomorpha* ROW and HÔZAWA[1], but it differs from the latter in the presence of subgastral radiates and in the larger size of tubar triradiates.

97. Leucandra valida LAMBE

Leucandra valida, LAMBE, 1900, pp. 32–33, Pl. 4, fig. 10, Pl. 5, fig. 11; DENDY and ROW, 1913, p. 771; BREITFUSS, 1932, p. 250; TANITA, 1941, p. 275, Pl. 17, fig. 9, text-fig. 3; 1942, p. 62.

Seven specimens of this species are contained in the collection. They were collected by Professor HÔZAWA from Onagawa Bay in 1941.

Each of them shows a solitary individual and is provided with an osculum at the upper end and it is surrounded by a well-developed collar.

They vary from 5 mm to 12 mm in total length. The dermal surface is highly hispid on account of the projecting large oxea. The colour in alcohol is dirty grey being contaminated with mud.

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[1] *Leucandra thulakomorpha*, ROW and HÔZAWA, 1931, pp. 791–794, Pl. 21, fig. 15, text-fig. 14.

Previously known Distribution:— Davis Strait, Exetor Harbour (LAMBE). *In Japan* — Onagawa Bay; Bôsyû Sunosaki; Simoda (TANITA).

Locality :— Onagawa Bay.

98. **Leucandra vermiformis** TANITA

Leucandra vermiformis, TANITA, 1941, pp. 277–279, Pl. 17, fig. 10, text-fig. 4.

Distribution :— Onagawa Bay, depth 15 meters (TANITA).

99. **Leucandra abratsbo** HÔZAWA

(Pl. XVII, figs. 63, 64)

Leucandra abratsbo, HÔZAWA, 1929, pp. 359–362, Pl. 9, figs. 57, 58, text-fig. 29; 1940, p. 53; TANITA, 1941, p. 273, Pl. 17, fig. 7; 1942, p. 46.

This species is represented by numerous specimens in the collection which were obtained from various localities. The number of the specimens is the richest in the present collections.

They vary both in size and shape considerably. Most of the specimens are solitary, but some others are colonial consisting of several individuals united together at their bases.

One of the larger specimens is shown in Pl. XVII, fig. 63. It forms an irregular colony with three oscula. It is about 30 mm in height and 27 mm in the greatest breadth. The surface of the sponge is uneven and is strongly hispid owing to the projecting large oxea.

The colour in alcohol is nearly white and the texture is rigid.

In respect to the canal system, the skeletal arrangement, and the spiculation, these specimens are exactly identical with those of the type specimen.

Previously known Distribution :— Misaki (HÔZAWA, TANITA); Noto-Wajima (HÔZAWA); Onagawa Bay; Kamakura; Simoda; Tateyama; Bôsyû Sunosaki; Awa-Kominato (TANITA).

Localities :— Enamura, Hukusima Prefecture; Owasi, Mie Prefecture; Sionomisaki, Tanabe Bay, and Kata, Wakayama Prefecture; Kamikawaguti, Kôti Prefecture; Hososima and Utimi, Miyazaki Prefecture; Tomioka, Kumamoto Prefecture; Mogi, Nagasaki Prefecture; Senzaki, Yamaguti Prefecture; Hamada, Hinomisaki, and Kagamura, Simane Prefecture; Hamasaka and Tuiyama Bay, Hyôgo Prefecture; Wakasa-Takahama, Hukui Prefecture, Sado-Aikawa, Niigata Prefecture.

Remarks :— This species was first described by HÔZAWA in 1929 and, afterwards, it was reported by the same author and by the writer as found abundantly in Noto, and in Tôhoku and Kantô districts.

As the writer stated in his previous report (1942), the present species seems to be one of the commonest Calcarea to be met with at many localities distributed along the coast of Japan.

100. **Leucandra globosa**, n. sp.

(Pl. XVII, fig. 65; Text-figs. 20, 21)

Two specimens of this new species exist in the collection which were obtained by Mr. HIRO in 1938 from Sakatahana and were deposited in the Museum of the Seto Marine Biological Station.

Each of the specimens represents a solitary individual of nearly oval form and is provided with an osculum surrounded by a well developed collar.

The largest specimen (Pl. XVII, fig. 63) is 9 mm in total length and is about 13 mm in the greatest diameter. The outer surface of the sponge is very slightly hispid, while the gastral surface is strongly hispid on account of the projecting apical rays of gastral quadriradiates. The osculum at the upper end of the body is circular in shape with a diameter of 2 mm and leads into the irregularly branched gastral cavity. The wall of the sponge is 3 mm thick in the middle parts of the body.

The colour in alcohol is pale grey and the texture is rather hard.

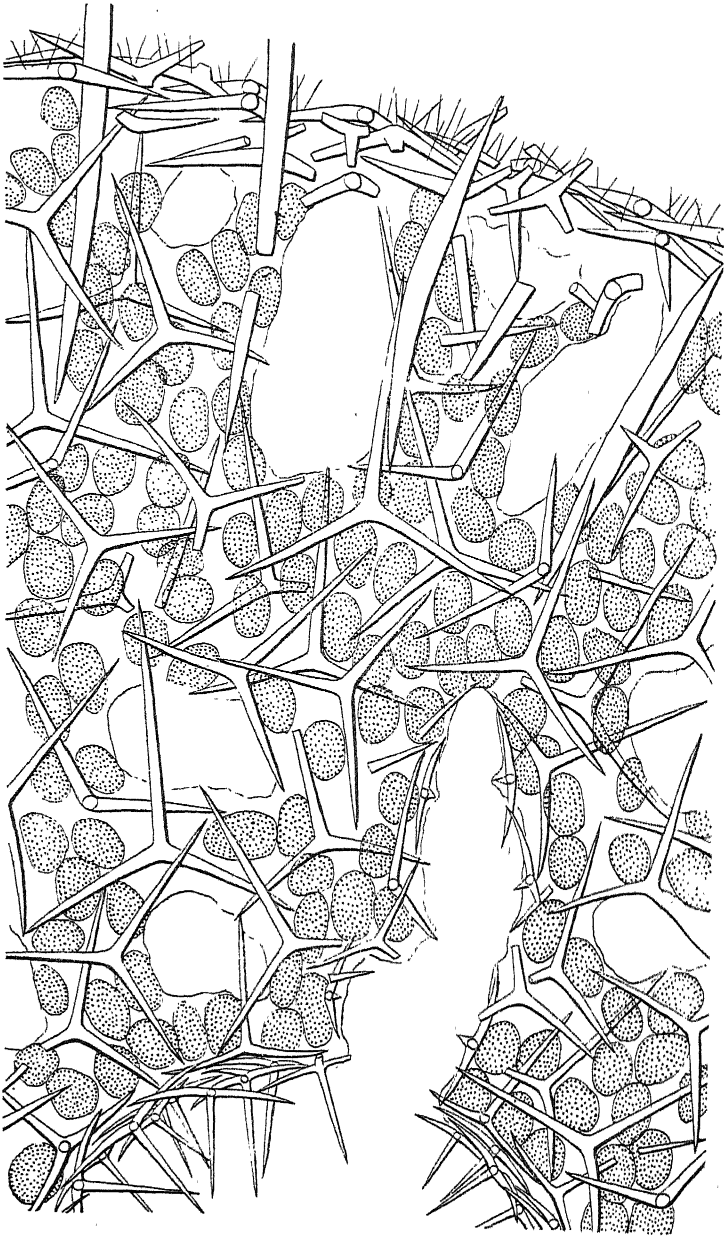
Structure (Text-fig. 20):—The canal system is of the leuconoid type. The flagellated chambers are either spherical or ovoid with a diameter of 70–100 μ and are thickly packed in the chamber layer.

The dermal skeleton is composed of triradiates, large oxea, and micr-oxea. The triradiates lie tangentially in a few layers and the large oxea occur sparcely and project to some extent from the dermal surface making nearly right angles with it. The microxea cover the dermal surface densely.

The skeleton of the chamber layer is made up mainly of tubar triradiates which are arranged confusedly. The proximal parts of large oxea and the basal rays of the subgastral tri- and quadriradiates are also added to the skeleton. The walls of larger exhalant canals are lined by several quadriradiates with the apical rays projecting into the canals.

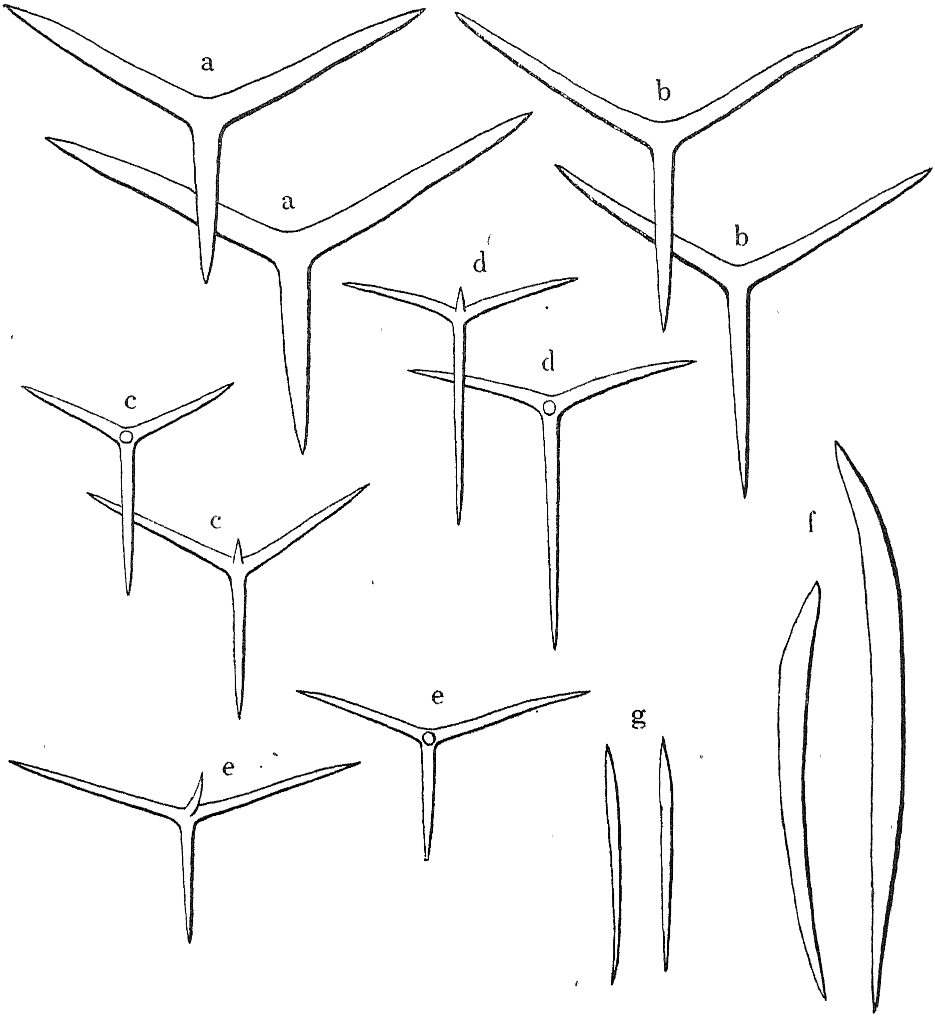
The gastral skeleton consists of gastral quadriradiates and of paired rays of subgastral tri- and quadriradiates. The gastral quadriradiates are placed tangentially in several layers and their long apical rays project freely into the gastral cavity.

The skeleton of the oscular margin is composed of linear spicules and of gastral quadriradiates with widely divergent paired rays. The



Text-fig. 20. *Leucandra globosa*, n. sp. Part of a cross-section. ×60.

former kind of spicules run longitudinally and thus make a developed oscular fringe.



Text-fig. 21. *Leucandra globosa*, n. sp. a, dermal triradiates; b, tubar triradiates; c, quadriradiates of larger exhalant canal; d, subgastral quadriradiates; e, gastral quadriradiates; f, large oxea; g, microxea. a–f ×75, g ×300.

Spicules (Text-fig. 21) :— Dermal triradiates (a) slightly sagittal. Basal ray straight, tapering towards sharply pointed end, shorter than paired rays, 300–380 μ long and 45–54 μ thick at base. Paired rays equal, nearly straight, 400–450 μ long and 45–54 μ thick at base.

Tubar triradiates (b) also slightly sagittal. Basal ray straight, sharply ended, either nearly equal to or slightly shorter than paired rays, 360-400 μ long and 22–33 μ thick at base. Paired rays equal, slightly curved forwards, 350–500 μ long and 22–33 μ thick at base.

Quadriradiates of larger exhalant canals (c) slightly sagittal. Basal ray straight, slightly longer than paired rays, 160-220 μ long and about 18 μ thick at base. Paired rays nearly equal, sharply pointed, 130–190 μ long and 18 μ thick at base. Apical ray sharply pointed, slightly curved, shorter than facial rays, 70–90 μ long and about 15 μ thick at base.

Subgastral triradiates are similar to quadriradiates of the same, only differing in the absence of apical ray.

Subgastral quadriradiates (d) strongly sagittal. Basal ray straight, sharply pointed, longer than paired rays, 200–360 μ long and 16-20 μ thick at base. Paired rays equal, widely divergent, 140–210 μ long and 16–20 μ thick at base. Apical ray short, curved slightly, shorter and thinner than facial rays, about 80 μ long and 13–16 μ thick at base.

Gastral quadriradiates (e) slightly sagittal. Basal ray straight, shorter than paired rays, 200–260 μ long and about 18 μ thick at base. Paired rays either nearly equal or unequal; sharply pointed, widely divergent, 220–280 μ long and 18 μ thick at base. Apical ray nearly straight, very finely pointed, variable in length, 200–420 μ long and 15–18 μ thick at base.

Quadriradiates of the oscular margin like the gastral quadriradiates but with wider oral angles.

Large oxea (f) elongate spindle shaped, slightly curved, sharply pointed at both ends, 630 μ–1.5 mm long and 45–60 μ thick in the thickest part.

Microxea (g) nearly straight, sharply pointed at both ends, smooth in outline, about 85 μ long and 3 μ thick.

Linear spicules of the oscular margin is straight, uniformly thick in the greater parts of their length except for the both ends, measuring up to 3 mm in length and about 5–8 μ in thickness.

Locality:— Sakatahana, near the Seto Marine Biological Station.

Remarks: — This species closely resembles URBAN's *Leucandra heathi*[1] in external form, but it may be easily distinguished from the latter by the spiculation.

101. **Leucandra impigra** TANITA

(Pl. XVII, fig. 66)

Leucandra impigra, TANITA, 1942, pp. 50–52, Pl. 4, fig. 23, text-fig. 9.

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[1] *Leucandra heathi*, URBAN, 1905, p. 59, Pls. 8, 9.

Many specimens of this species exist in the collection which were obtained by the writer from four different localities of Owasi, Tanabe Bay, Izumo-Esumi, and Amakusa. Most of the specimens are solitary and vary from nearly oval to irregular in form. At the upper end of each individual, there is a circular osculum which is either nearly naked or surrounded by a very feebly developed collar. The dermal surface is highly hispid due to the large oxea projecting from it.

The largest specimen (Pl. XVII, fig. 66) which was obtained in the neighbourhood of the Amakusa Marine Biological Station, measures 18 mm in length and 7 mm in the greatest breadth. The osculum of this specimen is naked and circular in shape with a diameter of 2 mm.

Previously known Distribution:— Kamakura and Enosima (TANITA).

Localities:— Owasi, Mie Prefecture; Tanabe Bay, Wakayama Prefecture; Amakusa-Tomioka; Izumo-Esumi.

Remarks:— The present species was described for the first time by the writer in 1942, using the specimens obtained from Kamakura and Enosima. This is, therefore, the second record of this species as found in the Japanese waters.

This species is very closely related to *Leucandra abratsbo* HÔZAWA, but may be easily distinguished from it by the presence of microxea on both of dermal and gastral surfaces and by the difference in spiculation.

102. Leucandra mediocanellata HÔZAWA

Leucandra mediocanellata, HÔZAWA, pp. 53–56, Pl. 4, fig. 7, text-fig. 9; TANITA, 1941, p. 274, Pl. 17, fig. 8.

Only a single specimen in the collection is assigned to this species. It was obtained by the writer from the shore of Inubômisaki. The sponge is rather small, being 4 mm in height, and shows a solitary individual which attaches by the base directly to the basal parts of some see-weed. The osculum at the upper end of the body is circular in shape and the dermal surface is hispid due to the projecting large oxea.

Previously known Distribution:— Rikuzen-Ôsima (HÔZAWA); Onagawa Bay (TANITA).

Locality:— Inubômisaki, Tiba Prefecture.

103. Leucandra mitsukurii HÔZAWA

(Pl. XVII, fig. 67)

Leucandra mitsukurii, HÔZAWA, 1929, pp. 350–353, Pl. 8, figs. 50, 51, text-fig. 26; TANITA, 1942, p. 55.

This species is represented by four specimens in the collection which were obtained in the neighbourhood of the Amakusa Marine Biological Station. They are all alike in appearance. Each of the specimens shows a solitary person and is provided with an osculum at its upper end.

The largest specimen (Pl. XVII, fig. 67) measures 15 mm in height and 12 mm in the greatest breadth. The dermal surface is uneven and hispid owing to the projecting oxea.

The colour in spirit is white and the texture is firm.

Previously known Distribution:— Misaki (Hôzawa); Simoda (Tanita).

Locality:— Tomioka, Kumamoto Prefecture.

Remarks:— The present species was described for the first time in 1929 by Hôzawa and, afterwards, it was reported by the writer from Simoda. This is the third record on the occurrence of this species in Japan.

104. **Leucandra multituba** Hôzawa

(Pl. XVII, figs. 68, 69)

Leucandra multituba, Hôzawa, 1929, pp. 365–367, Pl. 10, figs. 61, 62, text-fig. 31; Tanita, 1942, p. 55, Pl. 4, fig. 25.

Eight specimens of this species are contained in the collection. Of which, four were obtained from the shore of Sionomisaki, three were collected from the pearl oyster bed in Tanabe Bay, and the remaining one was secured in the neighbourhood of the Amakusa Marine Biological Station.

The largest specimen (Pl. XVII, fig. 68) which came from Sionomisaki is a solitary person in the form of nearly ovoid, provided with an osculum at the upper end. It measures 17 mm in length and 12 mm in the greatest breadth. The osculum is circular and is surrounded by a well-developed collar with the height of 2 mm. The dermal surface is hispid owing to the projecting oxea.

The colour in the preserved state varies from yellowish grey to dark grey and the texture is very firm.

Previously known Distribution:— Misaki (Hôzawa, Tanita); Simoda; Awa-Kominato (Tanita).

Localities:— Sionomisaki; Tanabe Bay, Amakusa-Tomioka.

Remarks:— This is the third report informing the occurrence of this species in Japanese waters.

105. **Leucandra nakamurai** Tanita

Leucandra nakamurai, Tanita, 1942, pp. 56–58, Pl. 4, fig. 26, text-fig. 11.

Distribution :— Awa-Kominato ; Simoda (TANITA).

106. **Leucandra paucispina** HÔZAWA

Leucandra paucispina, HÔZAWA, 1929, pp. 356–359, Pl. 9, figs. 55, 56, text-fig. 28.

Distribution :— Okinose, Sagami Sea (HÔZAWA).

107. **Leucandra rigida** HÔZAWA

Leucandra rigida, HÔZAWA, 1940, pp. 44–46, Pl. 4, fig. 3, text-fig. 5.

Distribution :— Wagu in Mie Prefecture (HÔZAWA).

108. **Leucandra sagamiana** HÔZAWA

Leucandra sagamiana, HÔZAWA, 1929, pp. 353–356, Pl. 9, figs. 53, 54, text-fig. 27.

Distribution :— Off Odawara, Sagami Sea, depth 171 meters (HÔZAWA).

109. **Leucandra sola** TANITA

Leucandra sola, TANITA, 1942, pp. 59–61, Pl. 4, fig. 28, text-fig. 12.

Distribution :— Misaki (TANITA).

110. **Leucandra solida** HÔZAWA

Leucandra solida, HÔZAWA, 1929, pp. 362–365, Pl. 10, figs. 59, 60, text-fig. 30.

Distribution :— Misaki (HÔZAWA).

111. **Leucandra spinosa** HÔZAWA

Leucandra spinosa, HÔZAWA, 1940, pp. 46–49, Pl. 4, fig. 4, text-fig. 6.

Distribution :— Wagu in Mie Prefecture (HÔZAWA).

112. **Leucandra cerebrum** HÔZAWA and TANITA

Leucandra cerebrum, HÔZAWA and TANITA, 1941, pp. 426–429, text-figs. 5, 6.

Distribution :— Akkesi Bay, Hokkaidô (HÔZAWA and TANITA).

113. **Leucandra dura** HÔZAWA

(Pl. XVIII, figs. 70, 71)

Leucandra dura, HÔZAWA, 1929, pp. 371–373, Pl. 12, figs. 66–68, text-fig. 32; 1933, p. 15, Pl. 1, fig. 7; TANITA, 1942, p. 47.

Several specimens contained in the collection are assigned to this species. Of these specimens, one was obtained by Dr. SATÔ in the neighbourhood of the Simoda Marine Biological Station, while the others were secured by the writer himself at the shore of Sionomisaki.

The specimen which came from Simoda (Pl. XVIII, fig. 70) represents a solitary individual of nearly oval form, more or less laterally compressed, and is provided with two naked oscula at the upper end. It measures 9 mm in height and 10.5 mm in the greatest breadth.

The largest specimen (Pl. XVIII, fig. 71) which was collected from a depth of about 4 meters off Sionomisaki, is of the shape of an irregularly rounded mass with a height of 25 mm and a maximum diameter of about 24 mm. It has three oscula which are naked and elliptical in form, measuring 1.5–5 mm in diameter. The dermal surface is folded and is harsh to touch.

The colour of the specimens is white. The texture is compact and very firm.

With respect to the internal structure and the spiculation, these specimens are exactly the same as those of the type specimen which was fully described by HÔZAWA.

Previously known Distribution:— Misaki; off Omaezaki (HÔZAWA); Simoda (TANITA).

Localities:— Simoda; Sionomisaki, Wakayama Prefecture.

114. **Leucandra folita** HÔZAWA

Leucandra foliata, HÔZAWA, 1918, pp. 547–549, Pl. 84, fig. 5, text-fig. 9; 1929, p. 370, Pl. 11, fig. 65; TANITA. 1942, p. 47, Pl. 4, fig. 21.

Distribution:— Off Ôsezaki, Kiusyû; off Niijima; Dôketsba and Okinose in Sagami Sea (HÔZAWA); off Hutamatiya, depth 15–20 fathoms (TANITA).

115. **Leucandra fragilis** HÔZAWA

Leucandra fragilis, HÔZAWA, 1940, pp. 51–53, Pl. 4, fig. 6, text-fig. 8.

Distribution:— Wagu in Mie Prefecture (HÔZAWA).

116. **Leucandra ohshimai** TANITA

(Pl. XVIII, fig. 72)

Leucandra ohshimai TANITA, 1939, pp. 322-325, text-figs. 3, 4.

Numerous specimens of this species were collected by the writer in

1940 in the neighbourhood of the Amakusa Maine Biological Station.

They are all quite typical so far as the structure of their skeleton and the size of their spicules are concerned. There is, however, some variation in the external form. The larger specimens are colonies of several tubular individuals, while the smaller ones are solitary. One of the larger specimens is shown in Pl. XVIII, fig. 72.

The length of the specimens varies from 15 mm to 75 mm. The osculum at the upper end of each tubular individual is naked and nearly circular in shape. Both dermal and gastral surfaces appear smooth to the naked eye.

The colour in spirit is yellowish grey and the texture is rather rigid.

With respect to the skeletal arrangement and the spiculations, these specimens at hand are identical with the type which was established by the writer, basing the description upon the materials came from Saseho.

Previously known Distribution:— Saseho in Nagasaki Prefecture (TANITA).

Locality:— Tomioka, Kumamoto Prefecture.

Remarks:— This species was first described by the writer in 1939, using three specimens obtained from Saseho. The species has hitherto been found only in Kiusyû.

117. Leucandra onigaseana HÔZAWA

Leucandra onigaseana, HÔZAWA, 1929, pp. 373–376, Pl. 12, figs. 69, 70, text-fig. 34.

Distribution:— Onigase in Sagami Sea; Niijima (HÔZAWA).

118. Leucandra pacifica HÔZAWA

Leucandra pacifica, HÔZAWA, 1929, pp. 368–370, Pl. 10, figs. 63, 64, text-fig, 32; TANITA, 1942, p. 58, Pl. 4, fig. 27.

Distribution:— Dôketsba in Sagami Sea (HÔZAWA); Mikomotojima; Simasita; Misaki (TANITA).

119. Leucandra tuba HÔZAWA

Leucandra tuba, HÔZAWA, 1918, pp. 542–544, Pl. 84, fig. 3, text-fig. 7; 1929, p. 367.

Distribution:— Near Okinosima, Tikuzen (HÔZAWA).

120. Leucandra tuberculata HÔZAWA

(Pl. XVIII, fig. 73, 74)

Leucandra tuberculata, HÔZAWA, 1929, pp. 342–344, Pl. 7, figs. 44, 45, text-fig. 23; TANITA, 1942, p. 61, Pl. 4, fig. 29.

This species is represented by many specimens in the collection which were obtained from seven different localities.

They are all solitary but vary in size, ranging from 3.5 mm to 15 mm in length.

The largest specimen (Pl. XVIII, fig. 73) which was collected in the neighbourhood of the Amakusa Marine Biological Station, consists of a solitary individual of an oval shape, more or less laterally compressed and is provided with a circular osculum with a diameter of 2.3 mm. The body is about 15 mm high and is 12 mm in the greatest breadth. The dermal surface appears to be tuberculated on account of the projecting tufts of oxea. The colour in spirit is nearly white with faint brownish tint and the texture is hard and rather elastic.

Previously known Distribution:— Misaki (HÔZAWA); Simoda; Awa-Kominato (TANITA).

Localities:—Inubômisaki, Tiba Prefecture; Toba Bay, Mie Prefecture; Tanabe Bay, Wakayama Prefecture; Tomioka, Kumamoto Prefecture; Mogi, Nagasaki Prefecture; Naha and Nago, Okinawa Prefecture.

Remarks:— This species was already reported by HÔZAWA (1929) and by the writer (1942) as found in the seas of Kantô District. The present species seems to be widely distributed in Japan, being obtained from many localities as mentioned above: from Okinawa in the south to Kantô district in the north.

The main characteristics of this species are the tuberculated dermal surface and the thick dermal skeleton, which is composed of many layers of large sagittal triradiates and which occupies 1/5–1/3 of the entire thickness of the body wall.

121. **Leucandra yuriagensis** HÔZAWA

Leucandra yuriagensis, HÔZAWA, 1933, pp. 16–19, Pl. 1, fig. 8, text-fig. 4.

Distribution:— Off Yuriage in Miyagi Prefecture, depth 37 meters (HÔZAWA).

122. **Leucandra amakusana**, n. sp.

(Pl. XVIII, fig. 75; Text-figs. 22, 23)

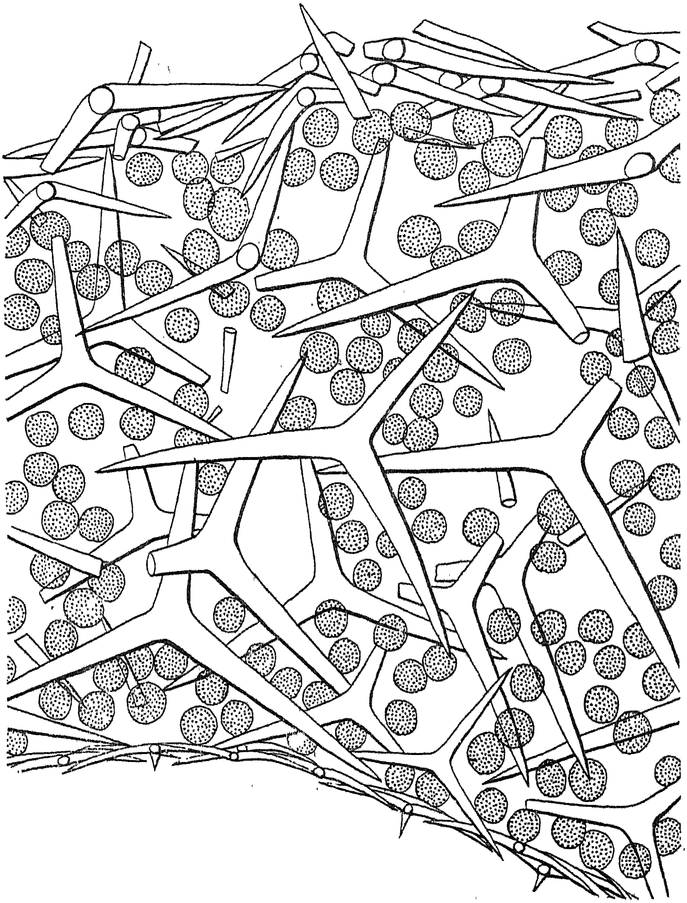
This new species is based upon six specimens contained in the collection. They were obtained by the writer in the neighbourhood of the Amakusa Marine Biological Station in March of 1940.

The specimens are all solitary but are variable in shape from nearly oval to strongly laterally compressed elongated tubular form.

The largest specimen (Pl. XVIII, fig. 75) which has served as the type of this new species is of an oval form with a naked osculum at its upper end. It is 8 mm high and 12 mm broad. The osculum is elliptical in shape with the longer diameter of 3 mm and the shorter of 1.5 mm and has no fringe. The dermal surface is nearly smooth without any projecting oxea and the gastral also seems nearly so to the naked eye, but is perforated by several large exhalant apertures. The sponge wall measures 4 mm thick in the middle part of the body.

The colour of the specimen in the preserved state is white and the texture is hard.

Structure (Text-fig. 22):—The canal system is of the leuconoid type.

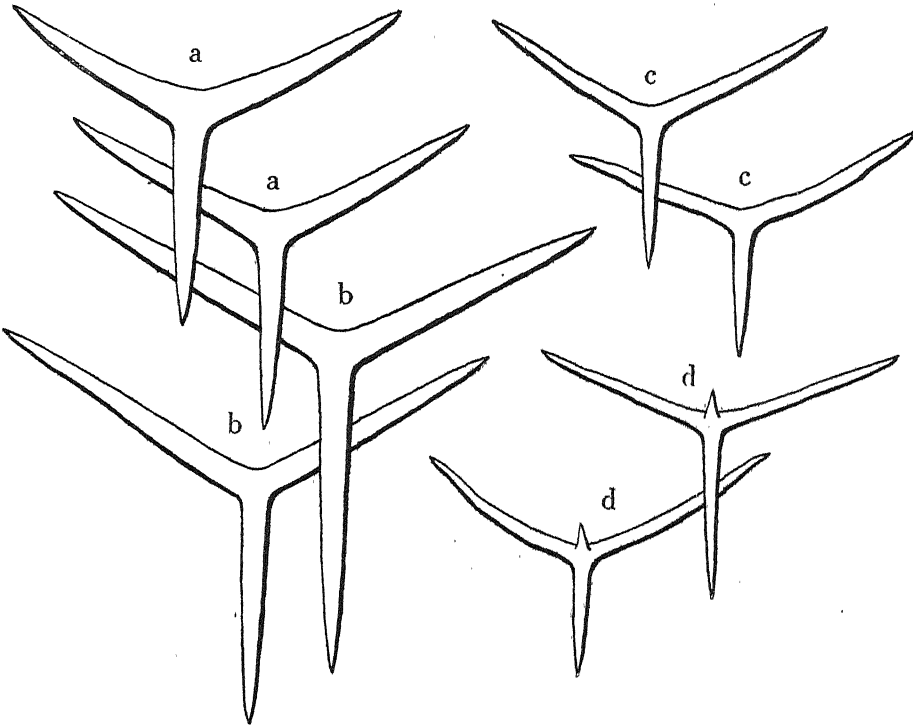


Text-fig. 22. *Leucandra amakusana*, n. sp. Part of a cross-section. ×60.

The flagellated chambers are either spherical or nearly so in shape, measuring 70–120 μ in diameter and are densely arranged in the chamber layer.

The dermal skeleton consists only of triradiates which are tangentially arranged in a few layers. The skeleton of the chamber layer is composed of numerous large tubar triradiates which are densely set together. The gastral skeleton is thinner than the dermal, being made up of two or three layers of tangentially placed gastral tri- and quadriradiates. The gastral quadriradiates are smaller in number in comparison with the triradiates of the same and the short apical rays project into the gastral cavity.

Spicules (Text-fig. 23):—Dermal triradiates (a) sagittal but all the rays are of equal length and are equally sharply pointed. Basal ray straight, while the paired rays curved forwards, 370–425 μ long and 40–50 μ thick at base.



Text-fig. 23. *Leucandra amakusana*, n. sp. a, dermal triradiates; b, tubar triradiates; c, gastral triradiates; d, gastral quadriradiates. All × 75.

Tubar triradiates (b) also sagittal and similar to dermal triradiates in shape, but larger and stouter than the latter. Rays measure 430–580 μ in length and 45–55 μ in thickness at base.

Gastral triradiates (c) sagittal. Basal ray straight, tapering towards sharp point, slightly shorter than paired rays, 180–260 μ long and 13–26 μ thick at base. Paired rays nearly equal, either straight or slightly curved forwards, 200–320 μ long and 13–26 μ thick at base.

Gastral quadriradiates (d) nearly similar to gastral triradiates, differing only in the presence of apical ray. Apical ray short, sharply pointed, curved oralwards, 40–60 μ long and about 18 μ thick at base.

Locality :— Tomioka, Kumamoto Prefecture.

Remarks :— As mentioned above, the skeleton of this species is composed mainly of triradiates, and the quadriradiates are very small in number. In this point, this species is very closely related to *Leucandra hentschelii* BRØNDSTED[1]; but it may be easily distinguished by the dimensions of all kinds of spicules, by the shape of gastral radiates, and by the absence of subdermal cavities.

123. **Leucandra consolida**, n. sp.

(Pl. XVIII, fig. 76; Text-figs. 24, 25)

This new species is based upon two specimens contained in the collection. They were secured by the writer himself in August of 1940 from the shore of Naha Bay, Okinawa Prefecture.

The writer has selected the larger specimen (Pl. XVIII, fig. 76), on which the further descriptions are to be based. The sponge consists of a solitary individual of irregularly massive form, strongly laterally compressed, and is attached by means of its base to the foreign object directly. It measures 12 mm in height, about 20 mm in the greatest breadth, and 9 mm in thickness. The osculum at the upper end of the body is circular in shape with a diameter of 2.5 mm and is surrounded by a very feebly developed collar. The dermal surface is not hispid without any projecting oxea but is uneven. The gastral cavity is relatively narrow and branches irregularly. The surface of the gastral cavity is perforated by the opening of large exhalant canals of nearly circular shape with a diameter of 1 mm. The sponge wall measures about 5 mm thick in the thickest parts.

The colour in spirit is white and the texture is very hard.

Structure (Text-fig. 24) :— The canal system is of the leuconoid type.

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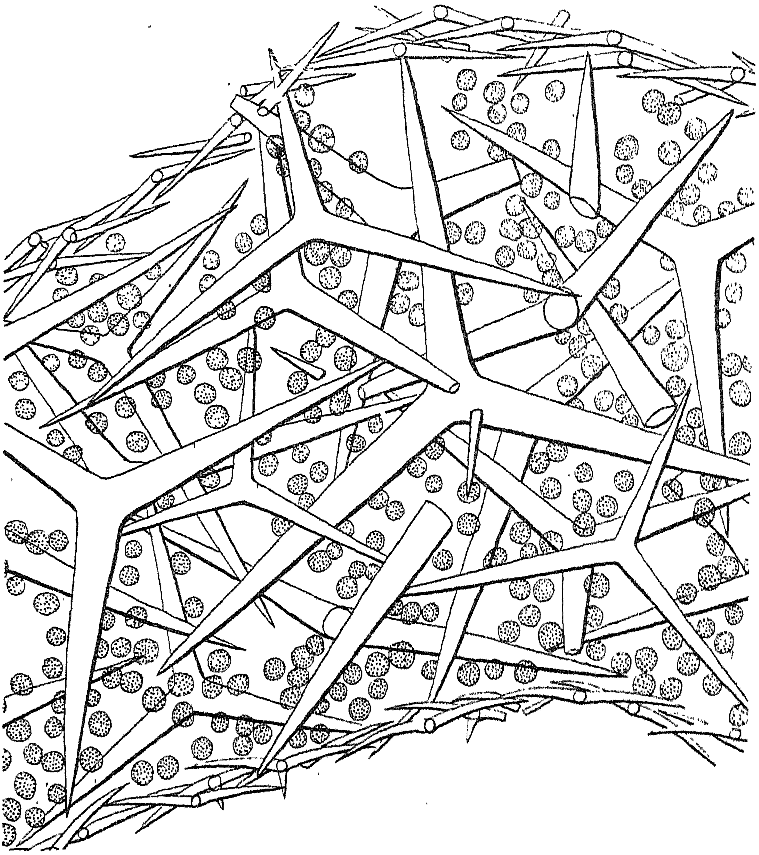
[1] *Leucandra hentschelii*, BRØNDSTED, 1928, pp. 40–41, fig. 31.

The flagellated chambers are nearly spherical in shape with a diameter of 35–60 μ and are densely packed in the chamber layer.

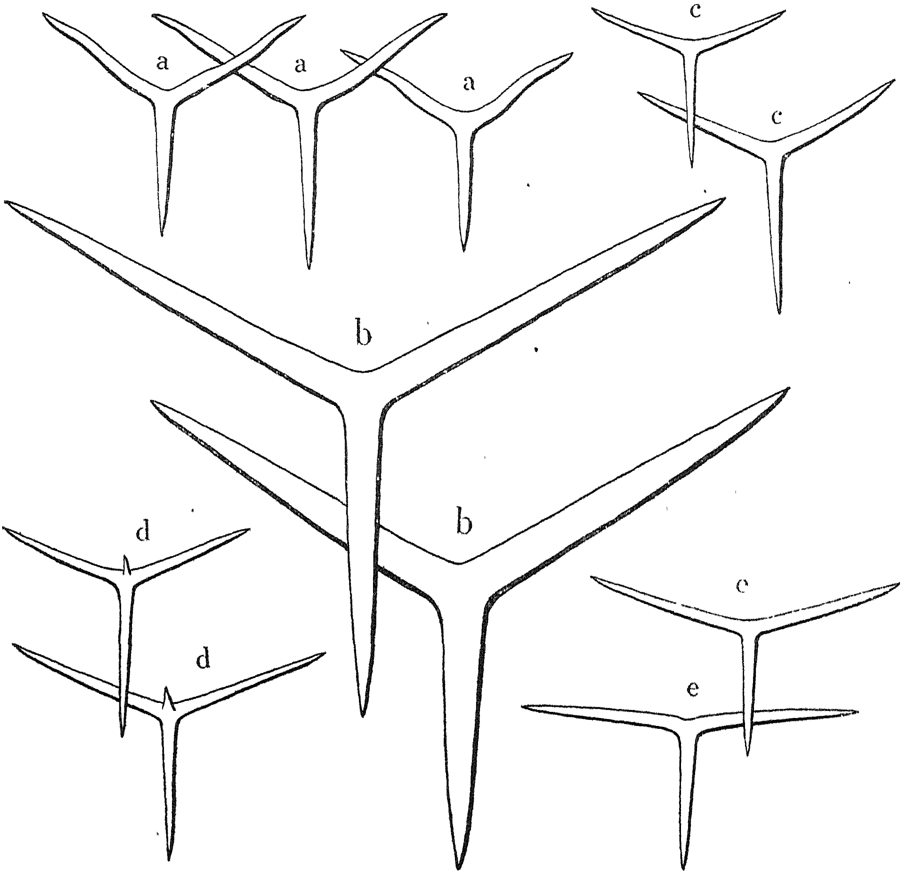
The dermal skeleton is rather thin, composed of a few layers of tangentially arranged triradiates. The skeleton of the chamber layer is made up of large tubar triradiates which are thickly and irregularly set together. The gastral skeleton is also thin and consists of the gastral tri- and quadriradiates which are placed in a few layers tangentially. The short apical rays of the gastral quadriradiates are projected into the gastral cavity. The gastral skeleton continues into the oscular collar and is modified near the oscular rim. Near the rim the quadriradiates almost disappear and the paired rays of the gastral triradiates become much more divergent.



Text-fig. 24. *Leucandra consolida*, n. sp. Part of a cross-section. ×60.

Spicules (Text-fig. 25):—Dermal triradiates (a) slightly sagittal but nearly equiradiates. Basal ray straight, tapering towards sharp point, 240–350 μ long and 20–25 μ thick at base. Paired rays equal and usually curved backwards near the sharp ends.

Triradiates of chamber layer (b) large, stout, and slightly sagittal.



Text-fig. 25. *Leucandra cansolida*, n. sp. a, dermal triradiates; b, fubar triradiates; c, gastral triradiates; d, gastral quadriradiates; e, triradiates of oscular margin. All × 75.

Basal ray straight, sharply ended, slightly shorter than paired rays, 550–720 μ long and 60–86 μ thick at base. Paired rays equal, nearly straight, 590–740 μ long and 60–86 μ thick at base.

Gastral triradiates (c) also sagittal. Basal ray straight, slightly longer than paired rays, 250–300 μ long and 15–18 μ thick at base. Paired rays equal, sharply pointed, slightly curved forwards, 220–270μ long and 15–18μ thick at base.

Gastral quadriradiates (d) like the gastral triradiates, only differing in the presence of short apical ray. Apical ray straight, sharply pointed, shorter and thinner than facial rays, about 80μ long and 14μ thick at base.

Triradiates of oscular margin (e) strongly sagittal. Basal ray straight, tapering towards sharply pointed end, shorter than paired rays, 130 200μ long and 16–20μ thick at base. Paired rays equal, curved forwards, widely divergent, 200–305μ long and 16–22μ thick at base.

Locality:— Naha, Okinawa Prefecture.

Remarks:— This species bears a marked resemblance to *Leucandra pumila* (BOWERBANK)[1], but it differs from the latter in the following several characteristics: 1) the spicules of the dermal cortex are of only one kind, 2) tubar triradiates of this species are always sagittal, 3) subgastral radiates absent, and 4) gastral radiates of this species are smaller than those of BOWERBANK's species.

124. **Leucandra glabra** HÔZAWA

Leucandra glabra, HÔZAWA, 1940, pp. 49–51, Pl. 4, fig. 5, text-fig. 7.

Distribution:— Wagu in Mie Prefecture (HÔZAWA).

Remarks:— This species was first described by HÔZAWA, using a single specimen obtained from Wagu by means of a coral-dredge. The most remarkable feature of this species consists in the presence of irregular spicules at the oscular margin.

125. **Leucandra okinoseana** HÔZAWA

Leucandra okinoseana, HÔZAWA, 1929, pp. 376–378, Pl. 12, figs. 71, 72, text-fig. 35.

Distribution:— Okinose in Sagami Sea (HÔZAWA).

126. **Leucandra palaoensis**, n. sp.

(Pl. XVIII, fig. 77; Text-fig. 26, 27)

There are eight specimens of this new species in the collection which were obtained from Palao, the Caroline Islands. They are either solitary or colonial.

One of the larger specimen (Pl. XVIII, fig. 77) on which the further descriptions are based, forms a rather simply branched colony, consisting of three tubular individuals. It grows vertically upwards, being attached directly to the substratum by means of its base. It measures 23 mm in height and 14 mm in breadth. The dermal surface of the body is smooth without any projecting oxea and the gastral appears also smooth to the naked eye. The sponge wall is comparatively thin being about 2 mm thick in the middle parts of the body and gradually becoming thinner towards the osculum. The osculum at the upper end of the individual is nearly elliptical in shape, measuring 4 mm long and 1.5 mm wide, and is surrounded by a very feebly developed collar.

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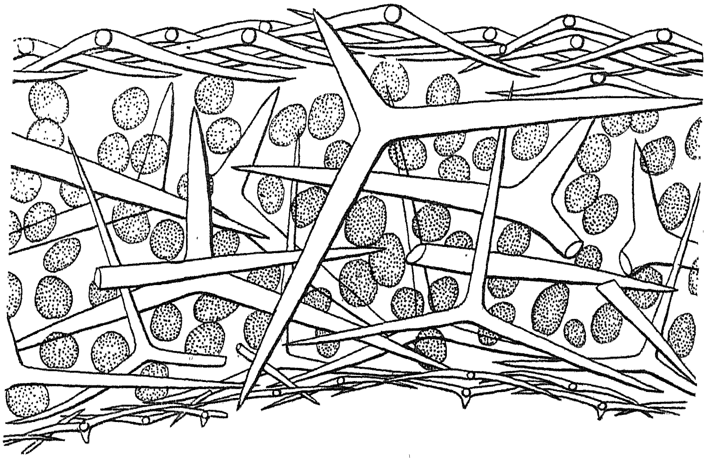
[1] *Leucandra pumila*, BOWERBANK, 1866, p. 41.

The colour in alcohol is rusty yellow and the texture is firm.

Structure (Text-fig. 26) :— The canal system is of the leuconoid type. The flagellated chamber are spherical or nearly so with a diameter of 80–130 μ and are set rather thickly in the chamber layer.



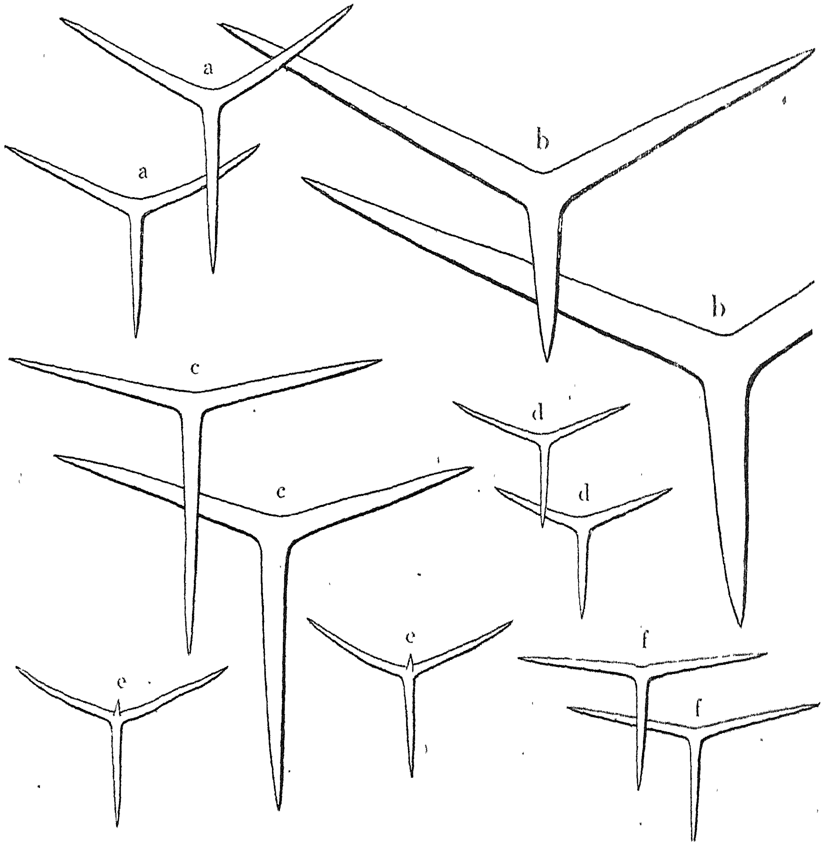
Text-fig. 26. *Leucandra palaoensis*, n. sp. Part of a cross-section. × 60.

The dermal skeleton is composed of triradiates which are placed almost without regard to the orientation save for the tangential disposition. The skeleton of chamber layer is made up of large tubar triradiates and of the centrifugal basal rays of subgastral triradiates.

The gastral skeleton is thinner than the dermal, consisting of a few layers of gastral tri- and quadriradiates and of the paired rays of subgastral triradiates.

The skeleton of the oscular margin is a close interlacement of triradiates and quadriradiates, both having paired rays very widely divergent and the basal rays downwardly directed.

Spicules (Text-fig. 27):—Dermal triradiates (a) slightly sagittal. Basal ray straight, tapering towards the sharply pointed end, 280–440 μ long and 23–35 μ thick at base. Paired rays equal, more or less curved forwards, slightly shorter than basal ray, 250–400 μ long and 23–35 μ thick at base.



Text-fig. 27. *Leucandra palaoensis*, n. sp. a, dermal triradiates; b, tubar triradiates; c, subgastral triradiates; d, gastral triradiates; e, gastral quadriradiates; f, triradiates of oscular margin. All × 60.

Tubar triradiates (b) sagittal and very large. All rays stout, more or less uneven in outline, equally thick being 65–90 μ at base. Basal ray straight, much shorter than paired rays being 310–470 μ long. Paired rays either equal or unequal, tapering towards sharp end being 720–1170 μ long.

Subgastral triradiates (c) strongly sagittal. Basal ray straight, sharply pointed, much longer than paired rays, 430–600 μ long and 33–55 μ thick at base. Paired rays nearly equal, divergent widely, straight or slightly curved backwards, 290–450 μ long and 33–55 μ thick at base.

Gastral triradiates (d) slightly sagittal and rays slender. Basal ray straight, sharply ended, 210–240 μ long and 14–20 μ thick at base. Paired rays nearly equal, slightly curved forwards, 210–300 μ long and 14–20 μ thick at base.

Gastral quadriradiates (e) exactly similar to the gastral triradiates, except for the presence of apical ray. Apical ray slightly curved, sharply pointed, shorter and thinner than facial rays, 40–70 μ long and about 10 μ thick at base.

Triradiates of oscular margin (f) strongly sagittal. Basal ray straight, tapering towards sharply pointed end, 200–260 μ long and 15–20 μ thick at base. Paired rays equal, nearly straight, widely divergent, 220–285 μ long and 15–22 μ thick at base.

Quadriradiates of oscular margin similar to the triradiates of the same, only differing in the presence of rudimental apical ray.

Locality:— Palao, Caroline Islands.

Remarks:—This species belongs to the Section D of the genus *Leucandra* without any kinds of oxea, but it seems to be quite distinct from any of the hitherto known species in the Section. It is remarkable for the presence of well-developed subgastral triradiates and of large tubar triradiates.

Genus **Leucopsila** DENDY and ROW (1913)

Diagnosis:— Canal system leuconoid. Skeleton of the chamber layer composed almost exclusively of irregularly scattered colossal quadriradiates. Gastral cortex well developed, but without any radiate spicules, the whole of the gastral skeleton being formed of a dense layer of microxea.

127. **Leucopsila stylifera** (O. SCHMIDT)

Leuconia stylifera, O. SCHMIDT, 1870, p. 73, Pl. 2, fig. 24.
Leucandra stylifera, HAECKEL, 1872, p. 225, Pl. 33, fig. 4, Pl. 40, fig. 11.
Leucopsila stylifera, DENDY and ROW, 1913, p. 776; HÔZAWA, 1918, pp. 554–556, Pl. 85, figs. 15, 16; 1929, p. 379.

Distribution:— Greenland (O. SCHMIDT, HAECKEL); off Cape Monati, Bering Island, Comandorski Islands (HÔZAWA). *In Japan*— Off Cape Rollin, Simushir Island (HÔZAWA).

Genus **Leucyssa** HAECKEL (1872) emend.

Diagnosis:— Canal system leuconoid. Skeleton entirely composed of smooth oxea.

128. **Leucyssa spongilla** HAECKEL

Leucyssa spongilla, HAECKEL, 1872, pp. 137–138, Pl. 25, figs. 11–13; HÔZAWA, 1929, p. 379.

Distribution:— Coast of Japan (HAECKEL).

Remarks:— This very interesting species was hitherto observed by HAECKEL only. None of the specimens of this species has been obtained by the writer in the collections made from the various localities in the Japanese waters.

H. Family **Amphoriscidae** DENDY

Diagnosis:— Flagellate chambers ranging from elongated and radially arranged to small, spherical and irregularly scattered. With a distinct dermal cortex supported by a skeleton of tangentially placed radiates to which oxea may be added. Some or all of the dermal radiates with large apical rays, which project inwards through the chamber layer to a greater or less extent, and form the principal part of its skeleton. No articulate tubar skeleton, but sometimes, in the leuconoid forms, a confused skeleton of quadriradiates in the chamber layer. Nuclei of collared cells probably always apical.

Genus **Leucilla** HAECKEL (1872) emend.

Diagnosis:— Canal system sylleibid or leuconoid. Skeleton of the chamber layer typically composed of the centripetally and centrifugally directed apical rays of subdermal and subgastral quadriradiates, but subgastral sagittal triradiates and confused chamber-layer quadriradiates may be present, while the subgastral quadriradiates may be absent.

129. **Leucilla hirsuta** TANITA

Leucılla hirsuta, TANITA, 1942, pp. 62–65, Pl. 4, fig. 30, text-fig. 13.

Distribution:— Awa-Kominato (TANITA).

Remarks:— The most conspicuous feature of this species exists in the presence of both large oxea and microxea.

130. **Leucilla minuta** TANITA

Leucilla minuta, TANITA, 1941, pp. 4–7, Pl. 1, figs. 5, text-fig. 1, 2.

Distribution:— Mutu Bay (TANITA).

I. Family **Lelapiidae** DENDY and ROW

Diagnosis:— Canal system presumably always leuconoid. Skeleton of the chamber layer containing fibres or bundles of modified sagittal triradiates placed side by side, but not cemented together. Nuclei of collared cells (presumably always) apical

Genus **Lelapia** GRAY (1867)

Diagnosis:— Skeleton of the chamber layer composed of large scattered oxea and loose fibres of tuning-fork spicules. Dermal skeleton of tangential triradiates and microxea. Gastral skeleton of tangential triradiates and quadriradiates.

131. **Lelapia nipponica** HARA

Lelapia nipponica, HARA, 1894, pp. 359–370, Pl. 8, figs. 1–13; HÔZAWA, 1929, p. 379.
Paralelapia nipponica, HÔZAWA, 1923, pp. 185–188, figs. 1–3.

Distribution:— Sagami Sea (HARA, HÔZAWA).

Remarks:—This interesting species was first described by HARA in 1894, basing the description upon the specimens obtained from the Sagami Sea. Afterwards it was fully reported by HÔZAWA in 1923, dealing with the material also secured from the Sagami Sea.

III. DISTRIBUTION OF CALCAREA IN JAPAN

With the purpose of studying the local distribution of the calcareous sponges in Japan, the Japanese waters are divided into ten divisions, according to their geographical situation, as follows:

I.	Hokkaidô and Karahuto	Station No. 1–5.
II.	Tôhoku District (Pacific side)	Station No. 6–15.
III.	Kantô District and its adjacent Localities	Station No. 16–27.
IV.	Kii Peninsula	Station No. 28–34.
V.	Sikoku District	Station No. 35–43.
VI.	Kiusyû District	Station No. 44–53.
VII.	Sanin District	Station No. 54–60.
IIIV.	Hokuriku and Ôu District	Station No. 61–69.
XI.	Okinawa District	Station No. 70–71.
X.	Caroline Islands	Station No. 72.

The localities included in each division and the number of species obtained there are shown in the following Table III.

TABLE III. Localities and the number of species obtained.

Station No.	Locality	Nos. of Families	Nos. of Genera	Nos. of Species
1.	Off Cape Patience, Saghalin.	1	1	1
2.	Simushir Island, Kuriles.	2	4	4
3.	Nemuro, Hokkaidô.	1	1	1
4.	Akkesi Bay, Ditto.	2	3	3
5.	Hakodate, Ditto.	1	1	1
Total Numbers of Calcarea found in Hokkaidô and Karahuto		3	8	9
6.	Mutu Bay, Aomori Prefecture.	4	4	6
7.	Hatinohe, Ditto.	1	1	1
8.	Off Kuji, Iwate Prefecture.	2	2	2
9.	Off Hudai, Ditto.	1	1	1
10.	Miyako Bay, Ditto.	1	1	1
11.	Kesennuma Bay, Miyagi Prefecture.	3	3	7
12.	Onagawa Bay, Ditto.	4	4	19
13.	Matusima Bay, Ditto.	3	3	6
14.	Off Yuriage, Ditto.	1	1	1
15.	Sioyazaki, Hukusima Prefecture.	2	2	2
Total Nos. of Calcarea found in Tôhoku District		5	6	30
16.	Inubômisaki, Tiba Prefecture.	1	1	2
17.	Awa-Kominato, Ditto.	5	6	15
18.	Tateyama & Sunosaki, Ditto.	5	8	21
19.	Misaki, Kanagawa Prefecture.	5	9	34
20.	Kamakura & Enosima, Ditto.	5	5	8
21.	Odawara, Ditto.	3	3	4
22.	Izu-Ôsima, Tokyo Prefecture.	1	1	1
23.	Izu-Niijima, Ditto.	1	1	2
24.	Simoda, Sizuoka Prefecture.	4	5	19
25.	Mikomotojima, Ditto.	1	1	1
26.	Enoura, Ditto.	1	2	3
27.	Omaezaki, Ditto.	1	1	1
Total Nos. of Calcarea found in Kantô District		7	14	62
28.	Toba Bay, Mie Prefecture.	4	6	17
29.	Wagu, Ditto.	4	5	10
30.	Ago Bay & Hamajima, Ditto.	4	4	12
31.	Owasi, Ditto.	4	5	13
32.	Sionomisaki, Wakayama Prefecture.	3	3	7
33.	Tanabe Bay, Ditto.	4	5	15
34.	Kata, Ditto.	3	3	5
Total Nos. of Calcarea found in Kii Peninsula		4	9	46

35.	Kannoura, Kôti Prefecture.	2	2	2
36.	Mimase & Usa, Ditto.	2	2	5
37.	Kamikawaguti, Ditto.	1	1	2
38.	Tatugusi, Ditto.	2	2	3
39.	Sukumo-Ôsima, Ditto.	2	2	5
40.	Hirayama & Uwajima, Ehime Prefecture.	2	2	4
41.	Yahatahama, Ditto.	2	2	2
42.	Takahama, Ditto.	3	3	4
43.	Onomiti, Okayama Prefecture.	1	1	1
Total Nos. of Calcarea found in Sikoku District		4	6	15
44.	Hososima, Miyazaki Prefecture.	4	5	6
45.	Aosima & Utimi, Ditto.	3	3	6
46.	Kagosima Bay, Kagosima Prefecture.	3	5	8
47.	Tikurajima, Ditto.	1	1	1
48.	Kosikijima, Ditto.	3	3	3
49.	Tomioka, Kumamoto Prefecture.	4	6	24
50.	Mogi, Nagasaki Prefecture.	4	4	8
51.	Ôsezaki, Ditto.	1	1	1
52.	Saseho, Ditto.	2	2	2
53.	Okinosima, Hukuoka Prefecture.	1	1	1
Total Nos. of Calcarea found in Kiusyû District		5	10	42
54.	Senzaki, Yamaguti Prefecture.	3	3	3
55.	Hamada, Simane Prefecture.	4	4	5
56.	Yunotu, Ditto.	2	2	2
57.	Hinomisaki, Ditto.	2	2	2
58.	Kagamura & Esumi, Ditto.	4	6	13
59.	Tuiyama Bay, Hyôgo Prefecture.	2	2	4
60.	Hamasaka, Ditto.	2	2	3
Total Nos. of Calcarea found in Sanin District		4	6	17
61.	Wakasa-Takahama, Hukui Prefecture.	4	4	9
62.	Wajima, Isikawa Prefecture.	3	3	5
63.	Notojima, Ditto.	1	1	1
64.	Sado-Aikawa, Niigata Prefecture.	3	3	4
65.	Sado-Ryôtu, Ditto.	1	1	1
66.	Tappizaki, Ditto.	1	1	1
67.	Nezugaseki, Yamagata Prefecture.	1	1	2
68.	Kamo, Ditto.	1	1	2
69.	Tutiyazaki, Akita Prefecture.	1	1	1
Total Nos. of Calcarea found in Hokuriku & Ôu District		4	6	18
70.	Nago, Okinawa Prefecture.	1	1	1
71.	Naha, Ditto.	6	7	14
Total Nos. of Calcarea found in Okinawa District.		6	7	14
72.	Palao, Caroline Islands.	3	4	5

From the table III, mentioned above, it seems to be clear that, as it might be expected, the number of species of Calcarea obtained from the Japanese coast of the Japan Sea is distinctly smaller than that of the Pacific coast of Japan. And, if the table is examined more precisely it may be also found that Kantô District seems to be the richest of the same group of sponges while the Caroline Islands are the poorest and, moreover, that the number of species secured from Sikoku District is smaller than that from Kiusyû, in spite of the fact that the former is placed geographically nearer to Honsyû where the fauna of Calcarea is very rich. Such peculiarities may be understood when we think that the fauna of Calcarea of Kantô and Kiusyû District were explored more fully than that of Sikoku District and of the Caroline Islands. When a number of researches are made in future of the fauna of Sikoku and of the Caroline Islands, it may be expected that such a marked difference in the richness of the fauna mentioned above will be greatly obliterated.

A. Horizontal Distribution

I. Homocoelidae

Thirty species of Homocoelidae have been reported from Japan till the present time. Of the said thirty species, 15 are proper to Japan, 5 are cosmopolitan, and the remaining 10 are common with Australia and other regions. Of the members of Homocoelidae found along the coasts of Japan, the greater was obtained from the Pacific side of Honsyû. They are 25 in all, complying with nearly 5/6 of Homocoelidae found in Japan. This may possibly due to the fact that the Pacific side of Honsyû is often visited by collectors and thus the fauna is possibly better known than that of any other areas of Japan.

From Hokkaidô and Karahuto, on the other hand, no species has hitherto been reported. From the Caroline Islands and Okinawa, only a few species were reported. When more collections have been made, the number of species may then be greatly increased.

Numerous specimens of *Leucosolenia stipitata* were obtained from various localities; from Okinawa in the south to the Onagawa Bay in the north. This species may be one of the commonest sponges to be found not noly in Japan but also in the world. This species, however, was reported hitherto only from Australia and Japan. This may be probably due to the fact that the sponge is small and is difficult to find it easily. When more careful collections have been done, the distribution of this species may then become more clear and thus it may become one of the cosmopolitan species.

Except for the cosmopolitan species, *Leucosolenia izuensis*, *L. laxa*, and *L. gardineri* have the widest distribution in the Japanese waters, being obtained from almost everywhere along the coasts of Japan, namely, from Tôhoku District in the north to Okinawa or Kiusyû in the south.

Three species, *Leucosolenia depressa*, *L. atlantica*, and *Dendya triradiata*, were found only in Okinawa. The former two species were reported till the present time from other regions too, but judging from the distributions, they seem to be tropical form.

Leucosolenia mutsu has also the wide distribution in Japan, but it is rather common in the northern parts of Honsyû.

TABLE IV. The table showing the members of the family Homocoelidae found in Japan, together with their geographical and bathymetric distributions.

	Honsyû		Sikoku	Kiusyû	Okinawa	Palao	Further distributions	Bathymetric distribution in fathoms
	Pacific side	Japan Sea side						
Leucosolenia amitsbo	+			+				50–400
L. atlantica					+		Cape Verde Is.	Littoral–20
L. australis	+		+				Observatory Bay	Sublittoral–
L. blanca	+		+				Cosmopolitan	Sublittoral–
L. canariensis	+	+			+	+	Cosmopolitan	Sublittoral–70
L. clathrata	+						Australia, New Zealand	unknown
L. coriacea	+	+		+	+		Cosmopolitan	Littoral
L. depressa					+		New Zealand	Sublittoral
L. eleanor			+				California	Littoral
L. gardineri	+	+		+	+		Chagos Archipelago	2–14
L. izuensis	+			+	+			Littoral
L. japonica	+							unknown
L. kagoshimensis	+			+				70–100
L. laxa	+	+		+			New Zealand	Littoral
L. minuta	+							Littoral
L. mollis	+							2–
L. mutsu	+	+						Littoral–
L. primordialis	+	+		+	+		Cosmopolitan	Sublittoral–
L. protogenes	+		+	+			Cosmopolitan	Sublittoral–
L. reticulum	+						Europe	Sublittoral–

L. sagamiana	+							90
L. serica	+							100–200
L. soyo	+	+						80
L. stipitata	+	+	+	+	+		Probably Cosmopolitan	Littoral
L. tenera	+			+				Littoral–4
L. ventosa	+							unknown
L. wilsoni	+						Australia	Littoral
Dendya quadripodifera	+							50–100
D. triradiata					+			Sublittoral

II. Sycettidae

As in the case of Homocoelidae, the most of the members of Sycettidae were secured in Honsyû. This may also be explained that in this region the collections have been done more fully than in any other districts.

Among the members of Sycettidae the following species are rather common along the coasts of Japan: *Sycon coronatum*, *S. luteolum*, *S. misakiensis*, *S. okadai*, and *S. rotundum*. Especially *Sycon okadai* is the richest, being obtained in a great number everywhere, from Kiusyû in the south to Kesennuma in the north. This species is found especially abundant in the calm bay where it is suitable for the oyster or pearl oyster culture, such as Sado-Ryôtu, Mangokuura, Kesennuma Bay, Ago Bay, and Toba Bay.

Sycon coronatum and *S. rotundum* are found mainly in the littoral zone, attaching to the underside of some rocks.

Sycon simushirensis is the representative from the cold water. On the other hand, *S. satsumensis*, *S. globulatum*, and *S. ensiferum* may be said to be tropical, being obtained from the seas where the climate is warm.

TABLE V. The table showing the members of the family Sycettidae found in Japan, together with their geographical and bathymetric distributions.

	Hokkaidô	Honsyû		Sikoku	Kiusyû	Okinawa	Palao	Further distribution	Bathymetric distribution in fathoms
		Pacific side	Japan Sea side						
Sycetta conifera					+			Adriatic Sea	50
Sycetta quadriradiata		+			+				50
Sycon album		+							unkown
Sycon calcar-avis		+							90
Sycon ciliatum		+						Cosmopolitan	Sublittoral

Sycon coronatum		+		+	+			Cosmopolitan	Littoral–
Sycon cylindricum		+							Sublittoral
Sycon digitiformis		+							180
Sycon ensiferum						+		Australia	Sublittoral
Sycon globulatum					+				unknown
Sycon lendenfeldi		+			+			Australia	Sublittoral
Sycon luteolum		+	+		+				Sublittoral
Sycon matsushimense		+	+						Littoral
Sycon misakiensis		+		+	+				Sublittoral
Sycon mundulum		+	+					Canada	3-60
Sycon okadai		+	+	+	+				Sublittoral
Sycon ornatum		+			+			New Zealand	Sublittoral
Sycon plumosum							+		unknown
Sycon pulchrum					+				100
Sycon raphanus		+						Cosmopolitan	unknown
Sycon rotundum		+	+	+	+				Sublittoral
Sycon satsumensis					+				unknown
Sycon simushirensis	+	+							5-
Sycon uragamii		+							Sublittoral
Sycon yatsui		+							unknown

III. Heteropiidae

Except for a single species of *Grantessa intusarticulata*, all the members of the Heteropiidae found in Japan are proper to the Japanese waters. Of which, *Grantessa mitsukurii*, *Heteropia striata*, and *Vosmaeropsis maculata* are very common along the coasts of Japan.

Grantessa intusarticulata which was reported by several foreign investigators from Australia and New Zealand, seems also to be widely distributed along the coasts of Japan, though it was reported only from the shores of Honsyû till the present time.

Grantessa nemurensis, *Heteropia medioarticulata*, and *Vosmaeropsis sasakii* are the representatives from the cold water, being found only in Hokkaidô and Kurile. On the contrary, there are no species which found only in the tropical sea.

From the Caroline Islands, no species which belongs to Heteropiidae has even been reported, and the reasons for this may due to the fact that the survey has not been thoroughly executed hitherto in the region.

TABLE VI. The table showing the members of the family Heteropiidae found in Japan, together with their geographical and bathymetric distributions.

	Hokkaidô	Honsyû		Sikoku	Kiusyû	Okinawa	Further distribution	Bathymetric distribution in fathoms
		Pacific side	Japan Sea side					
Grantessa nemurensis	+							unkown
G. shimeji		+						Sublittoral-
G. shimoda		+			+			3-5
G. intusarticulata		+	+				Australia, New Zealand	Sublittoral-
G. mitsukurii		+	+	+	+			Sublittoral-
G. bifida		+						unknown
G. ampullae			+					unknown
G. bas papillata		+						unknown
G. parva		+						20
Heteropia striata		+	+	+	+			Sublittoral-
H. medioarticulata	+							unknown
Amphiute ijimai		+						unknown
Vosmaeropsis japonica		+	+					Sublittoral-
V. grisea				+	+			Sublittoral?
V. spinosa					+			Littoral
V. maculata		+	+	+	+	+		Sublittoral-
V. sasakii	+							22

IV. Grantiidae

Most of the members of Grantiidae are proper to Japan as in the case of Heteropiidae.

Grantia uchidai, *Leucandra cerebrum*, and *L. kurilensis* are found in Hokkaidô only and thus they may be cold water forms, while *Leucandra kagoshimensis*, *L. ohshimai*, *L. tuba*, *Grantia hara*, and *G. stylata* are secured from the sea of Kiusyû where the climate is mild.

Leucandra abratsbo and *L. tuberculata* seem to be widely distributed in the Japanese waters. Especially the former is one of the commonest Calcarea to be met with on the shores of Honsyû, Sikoku, and Kiusyû. It is found chiefly on the rocks where the water current is strong.

TABLE VII. The table showing the members of the family Grantiidae found in Japan, together with their geographical and bathymetric distributions.

	Hokkaidô	Honsyû		Sikoku	Kiusyû	Okinawa	Palao	Further distribution	Bathymetric distribution in fathoms
		Pacific side	Japan Sea side						
Grantia harai					+				50
G. kujiensis		+							80
G. nipponica	+		+						130–230
G. uchidai	+								unknown
G. cupla		+(?)							unknown
G. glabra		+	+						82
G. stylata					+				50
Paragrantia waguensis		+							unknown
Ute armata		+			+				100–286
U. pedunculata		+							60–100
Achramorpha diomediae	+								230
Anamixilla torresi							+		Snblittoral?
Leucandra hozawai		+							Sublittoral 10
L. kagoshimensis					+				50
L. kurilensis	+								230
L. magna		+							100–200
L. odawarensis		+							90
L. tomentosa		+							Littoral–8
L. tropica							+		Sublittoral?
L. valida		+						Canada	5–20
L. vermiformis		+							8
L. abratsbo		+	+	+	+				Sublittoral-
L. globosa		+							unknown
L. impigra		+	+		+				Sublittoral
L. mediocanellata		+							Sublittoral
L. mitsukurii		+			+				Sublittoral
L. multituba		+							Sublittoral
L. nakamurai		+							Sublittoral
L. paucispina		+							unknown
L. rigida		+							unknown
L. sagamiana		+							90
L. sola		+							Sublittoral
L. solida		+							unknown
L. spinosa		+							unknown
L. cerebrum	+								unknown

L. dura		+							Sublittoral-
L. foliata		+							15-95
L. fragilis		+							unknown
L. ohshimai					+				Sublittoral
L. onigaseana		+							unknown
L. pacifica		+							unknown
L. tuba					+				59
L. tuberculata		+			+	+			Sublittoral-
L. yuriagensis		+							20
L. amakusana					+				Littoral
L. consolida						+			Sublittoral
L. glabra		+							unknown
L. okinoseana		+							unknown
L. palaoensis							+		unknown
Leucopsila stylifera	+							Greenland	230
Leucyssa spongilla		+							unknown

V. Other Families

The members of Leucascidae, Leucaltidae, Minchinellidae, Amphoriscidae, and Lelapiidae obtained from the Japanese waters are too small in number. In fact, each of these families is represented by a single or two species only, and moreover, it is known only from a few specimens secured from one locality. Therefore, the writer thinks that it is not enough to make here a general conclusion discussing the distributions of these families.

TABLE VIII. The table showing the members of each Leucascidae, Leucaltidae, Minchinellidae, Amphoriscidae, and Lelapiidae found in Japan, together with their geographical and bathymetric distributions.

	Honsyû Pacific side	Kiusyû	Okinawa	Further distribution	Bathymetric distribution in fathoms
Leucetta pyriformis			+	Indian Ocean	Littoral-45
Leucaltis clathria			+	Probably cosmopolitan	Littoral-
Leucaltis tenuis		+			50
Petrostroma schulzei	+				100-200
Leucyssa spongilla	+				unknown
Leucilla hirsuta	+				Sublittoral
Leucilla minuta	+				unknown
Lelapia nipponica	+				unknown

From the Table IV–VIII we are able to know that the fauna of calcareous sponges of Japan consists chiefly of those from Japan proper and of those to be identified extra-Japan, being the former predominated. Namely, of the recorded 131 species, 77 per cent. are proper to Japan, 8 per cent. are cosmopolitan, 8 per cent. are common with the species from the coasts of Australia and its adjacent regions, and the remaining 7 per cent. are the species common with those from the coast of Europe and America.

The writer may resume his opinion concerning the distribution of the Calcarea of Japan as follows: The Calcarea-fauna of Japan is more closely related to that of Australia than any other regions; and other possible relationship may be hardly found at the present state of our knowledge.

B. Bathymetric Distributions

To discuss the bathymetric distributions of the Japanese calcareous sponges, our knowledge is still far distant from the complete, being the collections have hitherto been undertaken mainly in the littoral or sublittoral zones. Only a few collections were made in the deep sea.

One of the most noticeable features concerning the bathymetric distribution of the Japanese Calcarea is the fact that the majority of them were found in shallow waters. Only a few following species may be regarded as the deep sea form at present: *Leucosolenia amitsbo* HÔZAWA, *L. kagoshimensis* HÔZAWA, *L. sagamiana* HÔZAWA, *L. serica* TANITA, *L. soyo* HÔZAWA, *Dendya quadripodifera* HÔZAWA, *Sycon calcar-avis* HÔZAWA, *S. digitiformis* HÔZAWA, *S. pulchrum* TANITA, *Grantia nipponica* HÔZAWA, *G. glabra* HÔZAWA, *Ute armata* HÔZAWA, *Leucandra kurilensis* HÔZAWA, *L. magna* TANITA, *L. odawarensis* HÔZAWA, *L. sagamiana* HÔZAWA, *Leucopsila stylifera* (O. SCHMIDT), and *Petrostroma schulzei* DÖDERLEIN. Most of the species, above-mentioned, were reported only once or twice. Comparatively few species, therefore, are regarded as the genuine deep sea type, except for those species known only from single specimen.

It might be assumed that the greater the bathymetric range increases, the wider the geographical distribution becomes. When the collections are undertaken more frequently in the deep sea, it will become clear that the relationship between the bathymetric and geographical distributions of the Japanese calcareous sponges in future.

IV. SYNOPSIS OF EACH FAMILY OF CALCAREA FOUND IN JAPAN

A. Keys to the genera and species of Homocoelidae

I. Diverticula of the gastral cavity, if any, never radially arranged around a central tube .... Genus *Leucosolenia* Bowerbank

II. From a large central individual lined by collared cells, radially arranged diverticula are given off .... Genus *Dendya* Bidder

Genus Leucosolenia Bowerbank (1864–1882)

I. — Without oxea.

  A. With triradiates only.

    1) Spicules regular.

      a. Spicules 2 kinds; dermal large, deep small .... *L. wilsoni* Dendy

      b. Spicules 1 kind, rays sharply pointed.

        i. Sponge forms irregular, spreading masses of Ascon-tubes with diameter of 0.15–0.6 mm. The wall of the Ascon-tubes is composed of a few layers of triradiates with the rays of 60–150 μ long and 8–14 μ thick .... *L. mutsu* Hôzawa

        ii. Sponge forms olynthus or auloplegma type, consisting of Ascon-tubes with diameter of 0.3–0.5 mm. The wall of the tubes is composed of a thin layer of triradiates with the rays of 180–200 μ long and 12–20 μ thick. .... *L. primordialis* (Haeckel)

        iii. Sponge forms auloplegma type, consisting of Ascon-tubes with diameter of 0.4–1 mm. The wall of the tubes is composed of a few layers of triradiates with the rays of 100–150 μ long and 8–12 μ thick. .... *L. protogenes* (Haeckel)

      c. Spicules 1 kind, rays bluntly ended. .... *L. coriacea* (Montagu)

    2) Spicules sagittal.

      a. Sponge forms a definite shape with a peduncle. Spicules are one kind. .... *L. stipitata* Dendy

      b. Sponge forms an irregular mass, peduncle absent. Spicules are two kinds, dermal large and deep small. .... *L. ventosa* Hôzawa

    3) Spicules regular and sagittal. .... *L. blanca* (Michlucho-Maclay)

    4) With tripod and regular spicules. .... *L. clathrina* (Carter)

  B. With sagittal quadriradiates only.

    1) Paired rays doubly curved in S-shape, longer than basal ray. .... *L. japonica* (Haeckel)

    2) Paired rays nearly straight, shorter than basal ray. .... *L. kagoshimensis* Hôzawa

  C. With triradiates and quadriradiates.

    1) Spicules regular.

      a. Triradiates equal to quadriradiates.

        i. Apical ray straight and thinner than facial rays. .... *L. canariensis* (Michlucho-Maclay)

        ii. Apical ray curved near the sharp end and slightly thicker than facial rays. .... *L. serica* Tanita

      b. Triradiates 2 kinds, large and small; quadriradiates equal to small triradiates.

i. Canal system is of the DENDY's reticulate type F. Rays of the larger triradiates are 200 μ long and 28 μ thick. .... *L. depressa* DENDY

ii. Canal system is of the DENDY's reticulate type E. Rays of the larger triradiates are 140 μ long and 12 μ thick. .... *L. gardineri* DENDY

iii. Canal system is of the DENDY's reticulate type D. Short stalk present. Rays of the larger triradiates are 130–175 μ long and 14–18 μ thick. .... *L. minuta* TANITA

iv. Canal system is of the DENDY's reticulate type D. Rays of the larger triradiates are 160–190 μ long and 14–18 μ thick. .... *L. soyo* HÔZAWA

2) Spicules regular and sagittal. .... *L. amitsbo* HÔZAWA

II. — With oxea, triradiates, and quadriradiates.

D. Radiates regular.

1) Tri- and quadriradiates are not equal size.

a. Radiates stout. Apical ray shorter than facial rays. Oxea slender, straight or slightly curved. .... *L. atlantica* THACKER

b. Radiates slender. Apical ray longer than facial rays. Oxea stout and always curved. .... *L. izuensis* TANITA

3) Tri- and quadriradiates are of the same size.

a. Apical ray equal to facial rays in length. .... *L. reticulum* (O. SCHMIDT)

b. Apical ray longer than facial rays.

i. Oxea alnce-head. Sponge forms a definite shape with pseudoderm. .... *L. pyriformis* TANITA

ii. Oxea solely sharply pointed. Sponge forms a loose colony and has no pseudoderm. .... *L. sagamiana* HÔZAWA

c. Apical ray shorter than facial rays. .... *L. laxa* KIRK

E. Radiates sagittal.

1) Oxea 2 kinds, large and small. .... *L. mollis* TANITA

2) Oxea 1 kind.

a. Basal ray longest, apical ray shortest. .... *L. australis* BRØNDSTED

b. Basal and paired rays equal, longer than apical ray. ...... *L. eleanor* URBAN

c. Paired rays longest, apical shortest. .... *L. tenera* TANITA

Genus **Dendya** BIDDER (1898)

I. — Pseudodermal skeleton consists of huge quadriradiates. ..*D. quadripodifera* HÔZAWA

II. — Pseudodermal skeleton consists of huge triradiates. .... *D. triradiata* TANITA

B. Key to the genus of Leucascidae

From the Japanese waters, only one genus and one species, *Leucetta pyriformis* DENDY, has been reported of this group. The short diagnosis of the genus is as follows:

Genns **Leucetta** HAECKEL (1872) emend.

Canal system leuconoid, with small, spherical or subspherical flagellated chambers irregularly scattered through the chamber layer. Skeleton consists mainly of equiangular and equiradiate spicules, which become sagittal at the oscular margin.

C. Keys to the genera and species of Leucaltidae

Family Leucaltidae contains, in our country, only a single genus *Leucaltis* HAECKEL.

Genus **Leucaltis** HAECKEL (1872) emend.

Sponge colony tubular, ramified and anastomosing, with many oscula. Flagellated chambers elongated and branched, more or less radially arranged round the central gastral cavity of the tubes.

I.— Gastral skeleton is very thin, being composed of minute tri- and quadriradiates. .... *L. clathrina* HAECKEL

II.— Gastral skeleton is fairly well-developed, being composed of large triradiates. .... *L. tenuis* HÔZAWA

D. Keys to the genera and species of Minchinellidae

In our country, the family Minchinellidae is represented by a single genus *Petrostroma* DÖDERLEIN, which contains only one species. The diagnosis of the genus is as follows:

Genus **Petrostroma** DÖDERLEIN (1892)

The quadriradiates of the skeleton of the chamber layer fused together laterally by calcareous cement into a network. Dermal skeleton of separate quadriradiates and triradiates and bunches of tuning-fork spicules.

E. Keys to the genera and species of Sycettidae

I.— Distal ends of flagellated chambers have no oxea. ....Genus *Sycetta* HAECKEL

II.— Distal ends of flagellated chambers always crowned with tufts of oxeote spicules..... .... Genus *Sycon* RISSO

Genus **Sycetta** HAECKEL (1872) emend.

I.— Subgastral quadriradiates absent. ....*S. conifera* (HAECKEL)

II.— Subgastral quadriradiates present. ....*S. quadriradiata* HÔZAWA

Genus **Sycon** RISSO (1826) emend.

I.— Flagellated chamber branched.
  A. Tubar quadriradiates and feebly developed dermal cortex present. .... *S. luteolum* TANITA
  B. Tubar quadriradiates absent.
    1) Oexa 2 kinds, large and small. Chambers branched into two or three. .... *S. cylindricum* TANITA
    2) Oxea 1 kind.
      a. Chambers divided into two or three branches. Body with long stalk. Oxea curved angularly.......................................*S. yatsui* HÔZAWA

b. Chambers branched repeatedly. Body without stalk. Oxea curved gently. .... *S. album* TANITA

II.— Flagellated chambers unbranched.

A. Tubar quadriradiates present.

1) Subgastral quadriradiates present.......... *S. calcar-avis* HÔZAWA

2) Subgastral quadriradiates absent.

a. Apical ray of gastral quadriradiates shorter than facial rays. Oxea at the distal ends of flagellated chambers slightly curved with the length of 150μ–1.2 mm. .... *S. rotundum* TANITA

b. Apical ray of the gastral quadriradiates longer than facial rays. Oxea at the distal ends of flagellated chamber straight with length of 180–210μ. Stouter radiates present at the oscular margin. .... *S. pulchrum* TANITA

B. Tubar quadriradiates absent.

1) Subgastral quadriradiates present.

a. Subgastral quadriradiates resemble in feature the digits of bird. Oxea 1 kind, sharply pointed at both ends. .... *S. digitiformis* HÔZAWA

b. Oxea 1 kind, lance-headed. Feebly developed dermal cortex present.......... *S. plumosum* TANITA

c. Oxea 1 kind, lance-headed. Dermal cortex absent... *S. matsushimense* TANITA

d. Oxea 1 kind, sharply pointed at both ends. Body with peduncle. .... *S. lendenfeldi* ROW and HÔZAWA

e. Oxea 2 kinds. Apical ray of gastral quadriradiates well-developed. .... *S. coronatum* (ELLIS and SOLANDER)

f. Oxea 3 kinds. Delicate peristome present around the osculum. .... *S. ornatum* KIRK

2) Subgastral quadriradiates absent.

a. Oxea 1 kind.

i. Ends of oxea like spear-head. .... *S. globulatum* HÔZAWA

ii. Oxea lance-headed.......... *S. okadai* HÔZAWA

iii. Oxea numerous, slender and indistinctly lance-headed.......... *S. satsumensis* HÔZAWA

iv. Oxea sharply pointed at both ends. Apical rays of gastral quadriradiates short. .... *S. ciliatum* (FABRICIUS)

v. Oxea sharply pointed at both ends. Body with peduncle. .... *S. uragamii* TANITA

vi. Oxea sharply pointed at both end and slightly curved. Tubar triradiates with basal ray of 100–140μ and 6μ thick. ......*S. simushirensis* HÔZAWA

vii. Oxea sharply pointed at both ends and nearly straight. Tubar triradiates with basal ray of 150–250μ and 10–12μ thick. ....*S. raphanus* O. SCHMIDT

b. Oxea 2 kinds.

i. Apical ray of gastral quadriradiates nearly as long as paired rays. .... *S. misakiensis* HÔZAWA

ii. Apical ray of gastral quadriradiates longer and thicker than facial rays. .... *S. mundulum* LAMBE

F. Keys to the genera and species of Heteropiidae

I.— Canal system syconoid. No colossal longitudinally placed oxea. .... **Genus *Grantessa* VON LENDENFELD**

II.— Canal system syconoid or sylleibid.
A. Dermal cortex with colossal longitudinal oxea. ....Genus *Heteropia* Carter
B. Both gastral and dermal cortices with colossal longitudinal oxea. ....Genus *Amphiute* Hanitsch
III.— Canal system sylleibid or louconoid. No colossal longitudinal oxea................. .... Genus *Vosmaeropsis* Dendy

Genus **Grantessa** von Lendenfeld (1885) emend.

I.— With large oxea, but without microxea.
A. Large oxea are arranged in small tufts. ....*G. shimeji* Hôzawa
B. Large oxea are not grouped in tufts.
1) Subgastral quadriradiates absent, but gastral triradiates present .... *G. sagamiana* Hôzawa
2) Subgastral quadriradiates present, but gastral triradiates absent. . *G. shimoda* Tanita
II.— With large oxea and microxea.
A. Microxea present on dermal surface. Large oxea club-shaped. Apical ray of gastral quadriradiates longer than facial rays. ....*G. nemurensis* Hôzawa
B. Microxea present on gastral surface. Large oxea spindle-shaped. Apical ray of gastral quadriradiates shorter than facial rays. ....*G. bifida* Tanita
III.— Without large oxea, but with microxea.
A. Tubar skeleton slightly articulate. Gastral quadriradiates with strongly developed apical ray present. ....*G. intusarticulata* (Carter)
B. Tubar skeleton inarticulate. Gastral quadriradiates absent. Apical ray of gastral quadriradiates shorter than facial rays. ....*G. mitsukurii* Hôzawa
IV.— Without any oxea in sponge wall.
A. Gastral quadriradiates absent. ....*G. ampullae* Hôzawa
B. Gastral quadriradiates present.
1) Microxea present at oscular margin. Apical ray of gastral quadriradiates much shorter than facial rays. ....*G. basipapillata* Hôzawa
2) Microxea absent. Apical ray of gastral quadriradiates well-developed, longer than facial rays...*G. parva* Tanita

Genus **Heteropia** Carter (1886) emend.

I.— Canal system sylleibid. Dermal oxea very distinct. Sponge colonial. . *H. striata* Hôzawa
II.— Canal system syconoid. Dermal oxea not very distinct. Sponge solitary. ....*H. medioarticulata* Hôzawa

Genus **Amphiute** Hanitsch (1894)

Of the genus *Amphiute* only a single species, *Amphiute ijimai* Hôzawa, is found in our country. The short diagnosis is as follows:

Sponge solitary, usually cylindrical in form with naked osculum. Canal system stands intermediate between sylleibid and leuconoid type. Both dermal and gastral cortices contain colossal longitudinally placed oxea. Tubar skeleton is inarticulate type. Microxea present on the dermal surface.

Genus **Vosmaeropsis** Dendy (1892)

I.—Large oxea and microxea present. Canal system leuconoid. . . . . . . *V. japonica* Hôzawa
II.—Large oxea present, but microxea absent.
  A. Canal system leuconoid. Tubar quadriradiates and gastral triradiates present, while subgastral quadriradiates absent. . . . . *V. grisea* Tanita
  B. Canal system is of the intermediate between sylleibid and leuconoid type. Subgastral quadriradiates present, while gastral triradiates absent. . . . . *V. spinosa* Tanita
III.—Without any kind of oxea.
  A. Canal system leuconoid. Tubar skeleton composed of confused triradiates and basal rays of subdermal and subgastral triradiates. . . . . *V. maculata* Hôzawa
  B. Canal system sylleibid. Tubar skeleton composed of the basal rays of subdermal and subgastral triradiates only. . . . . *V. sasakii* Hôzawa

F. Keys to the genera and species of Grantiidae

I.—Canal system syconoid.
  A. Tubar skeleton articulate.
    1) Colossal longitudinal oxea, if present, project from the surface. . . . . Genus *Grantia* Fleming
    2) Around each apopyle special skeleton composed of proper radiates present. . . . . Genus *Paragrantia* Hôzawa
    3) Dermal cortex well-developed, containing colossal longitudinal oxea. No tufts of oxea at the distal ends of the flagellated chambers. . . . . . . Genus *Ute* O. Schmidt
  B. Tubar skeleton inarticulate, no colossal longitudinal oxea.
    1) Tubar skeleton composed of basal rays of subgastral radiates with radial oxea projecting from the surface. . . . . Genus *Achramorpha* Jenkin
    2) Tubar skeleton composed of basal rays of subgastral radiates and of large triradiates arranged without regard to the direction of the chambers. . . . . Genus *Anamixilla* Poléjaeff
II.—Canal system leuconoid.
  C. Tubar skeleton confused. Colossal oxea, if present, always project from the surface. . . . . Genus *Leucandra* Haeckel
  D. Tubar skeleton composed of irregularly scattered colossal quadriradiates. No gastral radiates. Gastral skeleton formed of microxea. . .Genus *Leucopsila* Dendy and Row
  E. Skeleton entirely composed of smooth oxea. . . . . .Genus *Leucyssa* Haeckel

Genus **Grantia** Fleming (1828) emend.

I.—With large, usually radially arranged oxea, but without microxea.
  A. Subgastral quadriradiates present. Apical ray of gastral quadriradiates much shorter than facial rays. . . . . *G. kujiensis* Hôzawa
  B. Subgastral radiates absent. Gastral skeleton forms many bridge-like conjunctions. . . . . *G. uchidai* Hôzawa and Tanita
  C. Apical ray of gastral quadriradiates are enormously long. . . . *G. nipponica* Hôzawa
  D. Subgastral triradiates present. Tubar skeleton is articulate type in two or three rows. Apical rays of gastral quadriradiates not very long. . . . . . *G. harai* Hôzawa

E. Body with stalk. Dermal skeleton ill-defined from that of the chamber layer and tubar quadriradiates present. .... *G. stylata* HÔZAWA

II.— Without any oxea.

A. Subgastral quadriradiates present, while gastral triradiates absent. . *G. glabra* HÔZAWA

B. Quadriradiates absent. Gastral skeleton is composed of regular triradiates........ .... *G. cupla* (HAECKEL)

Genus **Paragrantia** HÔZAWA (1940)

Genus *Paragrantia* is represented by a single species, *Paragrantia waguensis* HÔZAWA, and the diagnosis of it is as follows:

Canal system syconoid. Sponge usually a simple branched colony. Tubar skeleton articulate, composed of radiate spicules, which is supplemented by oxea. Around each apopyle of the flagellated chambers there exists a special skeleton composed of proper quadriradiates which are arranged radially with apical rays projecting into the apopyle.

Genus **Ute** O. SCHMIDT (1862) emend.

I.— Body provided with stalk. Dermal oxea slender. .... *U. pedunculata* HÔZAWA

II.— Body without stalk. Dermal oxea very long and thick. .... *U. armata* HÔZAWA

Genus **Achramorpha** JENKIN (1908) emend.

This genus is represented by a single species, *Achramorpha diomediae* HÔZAWA, in Japan. The short diagnosis of it is as follows:

Sponge solitary. Canal system syconoid. Both dermal and gastral cortices very thin. Subgastral triradiates and gastral quadriradiates present, but microxea absent.

Genus **Anamixilla** POLÉJAEFF (1883)

Of this genus only one species, *Anamixilla torresi*, has been reported from the Japanese waters.

Genus **Leucandra** HAECKEL (1872) emend.

I.— With large oxea, but without microxea.

A. Quadriradiates absent.

1) Oxea provided with feebly developed lance-head. Tubar triradiates sagittal but equiangulate. Sponge solitary. .... *L. magna* TANITA

2) Oxea slender, slightly curved, sharply pointed at both ends. Tubar triradiates sagittal with wide oral angles and long basal ray. Sponge colonial. .... *L. kurilensis* HÔZAWA

3) Oxea slender, straight, very long and sharply pointed at both ends. Paired rays of tubar triradiates undulate. Body solitary with well-developed oscular collar. .. .. *L. tomentosa* TANITA

B. Quadriradiates present.

1) Subgastral quadriradiates present. Apical ray of gastral quadriradiates short.

a. Dermal quadriradiates absent. Tubar triradiates similar to the dermal..*L. kagoshimensis* HÔZAWA

b. Dermal quadriradiates present. Tubar triradiates large and stout. .... *L. tropica* TANITA

2) Subgastral quadriradiates absent.

a. Tubar quadriradiates present. Gastral skeleton composed of quadriradiates only with strongly developed apical ray....................*L. odawarensis* HÔZAWA

b. Oxea slightly lance-head. Basal ray of gastral radiates curved irregularly near the sharp end.................................. ....*L. vermiformis* TANITA

c. No distinct oscular fringe. Paired rays of gastral radiates widely divergent and longer than basal ray. .... *L. hozawai* TANITA

d. With a well-developed oscular collar. Paired rays of gastral radiates not so divergent and shorter than basal ray.......................*L. valida* LAMBE

II.—With large oxea and microxea.

A. Microxea present at oscular margin only which provided with lance-head. .... *L. mitsukurii* HÔZAWA

B. Microxea present on dermal surface.

1) Microxea spined, provided with lance-head at one end. Basal ray of gastral radiates straight. ....*L. abratsbo* HÔZAWA

2) Oxea smooth, sharply pointed at both ends or provided with lance-head at one end. Paired rays of tubar and gastral triradiates doubly curved. .... *L. mediocanellata* HÔZAWA

3) Oxea smooth, sharply pointed at both ends. Large oxea scattered in chamber layer. Basal ray of gastral radiates usually curved.........*L. multituba* HÔZAWA

4) Large oxea sharply pointed at both ends, while microxea provided with lance-head at one end. Dermal and tubar triradiates regular. Apical ray of gastral quadriradiates short. ....*L. nakamurai* TANITA

5) Large oxea sharply pointed at both ends, while microxea provided with lance-head at one end. Dermal and tubar triradiates subregular or sagittal. Apical ray of gastral quadriradiates strongly developed. ....*L. sola* TANITA

6) Large oxea and microxea sharply pointed at both ends. Subgastral tri- and quadriradiates present..*L. globosa* TANITA

C. Microxea present on gastral surface.

1) Large oxea provided with lance-head at one end. Microxea spined, provided with nodiform ring. Gastral skeleton mainly composed of quadriradiates............. .... *L. paucispina* HÔZAWA

2) Large oxea sharply pointed at both ends. Microxea spined, provided with lance-head at one end. Gastral skeleton composed mainly of tri- and quadriradiates.. .... *L. sagamiana* HÔZAWA

D. Microxea present on both dermal and gastral surfaces.

1) Both dermal and gastral microxea spined. Gastral microxea numerous. Subgastral quadriradiates absent. ....*L. impigra* TANITA

2) Both dermal and gastral microxea provided with nodiform ring. Dermal and tubar triradiates regular. Gastral triradiates absent. ....*L. rigida* HÔZAAW

3) Both dermal and gastral microxea sharply pointed at both ends. Radiates all sagittal. ....*L. spinosa* HÔZAWA

4) Dermal microxea spined and provided with nodiform ring. Gastral microxea sharply pointed at both ends and provided with nodiform ring at one end. Dermal triradiates 2 kinds, large regular and small sagittal. ......*L. solida* HÔZAWA

III.— With microxea, but without large oxea.
  A. Microxea present on dermal surface.
    1) Microxea provided with lance head. Dermal triradiates slightly sagittal and tubar triradiates subregular. .... *L. cerebrum* HÔZAWA and TANITA
    2) Microxea at the oscular margin provided with nodiform ring. Dermal cortex very thick. .... *L. tuberculata* HÔZAWA
    3) Dermal microxea spined. Dermal triradiates 2 kinds, large regular and small sagittal. .... *L. ohshimai* TANITA
  B. Microxea present on gastral surface.
    1) Microxea irregular in outline. Gastral triradiates 2 kinds, regular and sagittal.. .... *L. foliata* HÔZAWA
    2) Microxea pointed at both ends. Gastral triradiates absent. Hair-like spicules present on dermal surface. .... *L. pacifica* HÔZAWA
    3) Microxea spined. Hair-like spicules absent. Gastral triradiates 2 kinds, large regular and small sagittal. .... *L. yuriagensis* HÔZAWA
  C. Microxea present on both dermal and gastral surfaces.
    1) Dermal and gastral microxea spined, curved S-like, provided with nodiform ring. Dermal triradiates slightly sagittal, tubar triradiates regular or subregular. Apical ray of gastral quadriradiates short. .... *L. dura* HÔZAWA
    2) Both dermal and gastral microxea smooth, straight, provided with nodiform ring. Dermal triradiates regular or subregular. Gastral skeleton composed mainly of quadriradiates. .... *L. fragilis* HÔZAWA
    3) Microxea irregular in outline. Dermal triradiates slightly sagittal, tubar triradiates regular or subregular. Apical ray of gastral quadriradiates well-developed....... .... *L. onigaseana* HÔZAWA
    4) Microxea smooth, provided with lance-head at one end. Dermal triradiates 2 kinds, large regular or subregular and small sagittal. Tubar triradiates regular. Gastral quadriradiates absent. .... *L. tuba* HÔZAWA

IV.— Without any oxea.
  A. Tubar triradiates 2 kinds, large and small, both regular. Gastral quadriradiates absent. Irregular triradiates present at the oscular margin. .... *L. glabra* HÔZAWA
  B. Dermal triradiates 2 kinds, large regular and small sagittal. Gastral skeleton contains tri- and quadriradiates. .... *L. okinoseana* HÔZAWA
  C. Dermal and tubar triradiates equiradiate. Skeleton is composed mainly of triradiates. Quadriradiates are very small in number. .... *L. amakusana* TANITA
  D. Dermal triradiates equiradiate, while other radiates sagittal. Subgastral radiates absent. .... *L. consolida* TANITA
  E. All radiates sagittal. Large subgastral triradiates present, while subgastral quadriradiates absent. .... *L. palaoensis* TANITA

Genus **Leucopsila** DENDY and ROW (1913)

The only known species of this group is *Leucopsila stylifera* (O. SCHMIDT). The short diagnosis of it is as follows:

Canal system leuconoid. Skeleton of the chamber layer composed almost exclusively of irregularly scattered colossal quadriradiates. Gastral cortex well developed, but without any radiates, the whole of the gastral skeleton being formed of a dense layer of microxea.

Genus **Leucyssa** HAECKEL (1872) emend.

This genus contains only a single species, *Leucyssa spongilla* HAECKEL, the diagnosis of which is as follows:

Canal system leuconoid. Skeleton entirely composed of smooth oxea.

G. Keys to the genera and species of Amporiscidae.

Of this group only one genus, *Leucilla* HAECKEL, has been reported from Japan.

Genus **Leucilla** HAECKEL (1872) emend.

I.—With large oxea and microxea. . . . . *L. hirsuta* TANITA
II.—With large radially arranged oxea, but without microxea. . . . . *L. minuta* TANITA

H. Keys to the genera and species of Lelapiidae

Only on genus, *Lelapia* GARY, has been reported from the Japanese waters.

Genus **Lelapia** GRAY (1867)

Genus *Lelapia* is represented in our country by a single species, *Lelapia nipponica* HARA, of which diagnosis is as follows:

Skeleton of the chamber layer composed of radially arranged loose fibres of tuning-fork spicules and of the basal rays of subgastral sagittal triradiates. Dermal skeleton of tangential triradiates and of large longitudinally arranged oxea. Gastral skeleton of tangential triradiates and quadriradiates.

V. LIST OF LITERATURES

ARNESEN, E. (1901). Spongier fra den norske kyste. I. Calcarea. Systematisk katalog med bemerkninger og bestemmelsestable. Bergens Mus. Aarbog. No. 5.

BIDDER, G. P. (1) (1891). "Review." 'A Monograph of Victorian Sponges,' by ARTHUR DENDY. Part I. The Organisation and Classification of the Calcarea Homocoela, with Descriptions of the Victorian Species. Quart. Journ. Micros. Sci. (n. s.) Vol. 32, pp. 625–632.

—— (2) (1898). The Skeleton and Classification of Calcareous Sponges. Proc. Roy. Soc. London, Vol. 64, No 403, pp. 61–76.

BOWERBANK, J. S. (1) (1845). Description of a new Genus of Calcareous Sponges (*Dunstervilla*). Ann. Mag. Nat. Hist. (ser. 1) Vol. 15, pp. 297–300.

—— (2) (1858–'62). On the Anatomy and Physiology of the Spongiadae. Part I. Phil. Trans. Roy. Soc. Londou, Vol. 148, pp. 279–332. Part II. ibid. Vol. 152, pp. 747–836.

—— (3) (1862). On the Anatomy and Physiology of the Spongiadae. Part III. On the Generic Characters, the Specific Characters, and Method of Examination. Phil. Trans. Roy. Soc. London, Vol. 152, pp. 1087–1135.

BOWERBANK, J. S. (4) (1864–1882). A monograph of the British Spongiadae. Roy. Soc. London, 4 Vols.

—— (5) (1872–1876). Contributions to a general History of the Spongiadae. Proc. Zool. Soc. London, (1872) pp. 115–129; 196–202; 626–634; (1873) pp. 3–25; 319–333; (1874) pp. 298–305; (1875) pp. 281–296; (1876) pp. 768–775.

BREITFUSS, L. (1) (1896). Kalkschwämme der Bremer-Expedition nach Ost-Spitzbergen im Jahre 1889. Zool. Anz., Bd. 19, No. 514, pp. 426–432.

—— (2) (1896). *Amphoriscus semoni*, eine neue Art heterocoeler Kalkschwämme. Zool. Anz., Bd. 19, pp. 435–436.

—— (3) (1896). *Ascandra Hermesi*, ein neuer homocoeler Kalkschwamm aus der Adria. Zeit. wiss. Zool., Bd. 63, Heft 1, pp. 39–42.

—— (4) (1897). Catalog der Calcarea der zoologischen Sammlung des königlichen Museums für Naturkunde zu Berlin. Arch. f. Naturgesch. Jahrgang 63, Bd. 1, pp. 205–226.

—— (5) (1898). Kalkschwammfauna des weisen Meeres und der Eismeerküsten des europäischen Russlands mit Berücksichtigung und Aufstellung der Kalkschwammfauna der arktischen Region. Mémoires de l'Acad. Impér. des Sciences, St. Pétersbourg, (ser. 8) Vol. 6, No. 2.

—— (6) (1898). Die arctische Kalkschwämmfauna. Inaugural-Dissertation zur Erlangung der Doctorwürde von der Philos. Fak. Univ. Zürich, pp. 1–40.

—— (7) (1898). Kalkschwammfauna der Westküste Portugals. Zool. Jahrb. Syst. Abth., Bd. 11, pp. 89–102.

—— (8) (1898). Die Kalkschwammfauna von Spitzbergen. Nach den Sammlungen der Bremer-Expedition nach Ost-Spitzbergen im Jahre 1889. Zool. Jahrb. Syst. Abth., Bd. 11, pp. 103–120.

—— (9) (1898). Die Kalkschwämme der Sammlung Plate (Fauna Chilensis, Bd, 1). Zool. Jahrb. Suppl.-Bd. 4, pp. 455–470.

—— (10) (1898). *Amphoriscus semoni*, ein neuer heterocoeler Kalkschwamm (Semon, Zoologische Forschungsreisen Australien malayischen Archipels, Bd. V, Lief, 4) Denkschrift. med.-nat. Ges. Jena, Bd. 8, pp. 381–384.

—— (11) (1912). Zur Kenntnis der Spongio-Fauna des Kola-Fjords. Trav. Soc. Nat. Petersbourg, Vol. 42, Liver. 1, pp. 223–226.

—— (12) (1927). Die Kalkschwammfauna der Nord- und Ostsee. Zool. Anz., Bd. 70, pp. 26–36

—— (13) (1929). Zur Kalkschwammfauna des Meerbusens von Biskaya. Zool. Anz., Bd. 83, pp. 261–265.

—— (14) (1932). Die Kalkschwammfauna des arktischen Gebietes. Fauna arctica, pp. 237–252.

—— (15) (1935). Le Spugne calcaree dell'Adriatico con riflesso a tutto il Mediterraneo. Comitata. Talassografico Italiano Mem. 223, pp. 1–43.

—— (16) (1936) Kalkschwämme vom Skagerrak und Kattegat unter Berücksichtigung ihrer Weltverbreitung. Göteborg. Kungl. Vetenskaps och Vitterhets Samhälles Handlingar Femte Följden, ser, B. Bd. 4, No. 15.

BRØNDSTED, H. V. (1) (1923). Sponges from the Auckland and Campbell Islands. Papers from Dr. TH. MORTENSEN's Pacific Expedition 1914–16. XV. Vidensk. Medd. fra Dansk Naturh. Foren., Bd. 75.

—— (2) (1926). Sponges from New Zealand. Part II. Paper from Dr. TH. MORTENSEN's Pacific Expedition 1914–16. XXXV. Vidensk. Medd. fra Dansk naturh. Foren, Bd. 81, pp. 295–331.

BRØNDSTED, H. V. (3) (1928). Die Kalkschwämme der deutschen Südpolar-Expedition 1901-1903. Deutsche Südpolar-Expedition XX. Zoologie, pp. 1-47.

BURTON, M. (1) (1926). Report on the Sponges. Trans. Zool. Soc., Part 1, pp. 71-83.

—— (2) (1929). British Antarctic ("Terra nova") Expedition, 1910. Porifera. Part II. Antarctic Sponges. Nat. Hist. Rep. Zool., Vol. 6, No. 4, pp. 393-458.

—— (3) (1930). Norwegian Sponges from the Norman Collection. Proc. Zool. Soc. London, Part 2, pp. 487-546, Pls. I, II.

—— (4) (1930). The Porifera of the Siboga Expedition. III. Calcarea. Siboga-Expeditie, pp. 1-17.

—— (5) (1932). Sponges. Discovery Reports, Vol. 6, pp. 237-392, Pls. 48-57.

—— (6) (1933). Report on a small Collection of Sponges from Stil Bay, S. Africa. Ann. Mag. Nat. Hist., ser, 10, Vol. 11, pp. 235-244.

—— (7) (1934). Sponges. Great barrier Reef Expedition 1928-29. Scientific Report. Vol. 4, No. 14, pp. 513-621, Pls. I, II.

—— (8) (1934). Sponges. Swedish Antarctic Expedition 1901-1903. Vol. 3, No. 2, pp. 1-58, Pls. 1-8.

—— (9) (1934). Report on the Sponges of the Norwegian Expeditions to East-Greenland (1930-1932). Skrifter om Svalbard og Ishavet, Nr. 61, pp. 1-40.

BURTON, M. and RAO, H. S. (1932). Report on the Shallow-water Marine Sponges in the Collection of the Indian Museum. Records. Indian Mus., Vol. 34, Part 3, pp. 299-356, Pl. 18.

CARTER, H. J. (1) (1871). On two undescribed Sponges and two Esperiadae from the West Indies; also on the nomenclature of the calcisponge *Clathrina*, GRAY. Ann. Mag. Nat. Hist., ser, 4, Vol. 7, pp. 268-283.

—— (2) (1871). A Description of two new Calcispongiae (*Trichogypsia*, *Leuconia*), to which is added confirmation of Prof. J. CLARK's discovery of the true form of the sponge-cell (Animal) and an account of the polypelike pore-area of *Cliona corallinoides*, contrasted with Prof. E. HAECKEL's view on the relationship of the Sponges to the Corals. Ann. Mag. Nat. Hist., ser. 4, Vol. 8, pp. 1-28.

—— (3) (1877). Arctic and Antarctic Sponges. Ann. Mag. Nat. Hist., ser. 4, Vol. 20, pp. 38-42.

—— (4) (1878). On *Teichonia*, a new family of Calcareous Sponges, with descriptions of two Species. Ann. Mag. Nat. Hist., ser. 5, Vol. 2, pp. 35-40.

—— (5) (1883). Further Observations on the so-called 'Farringdon Sponges' (Calcispongiae, Zittel), followed by a description of an existing species of a like kind (*Leucetta clathrata*, n. sp.). Ann. Mag. Nat. Hist., ser. 5, Vol. 11, pp. 20-37.

—— (6) (1885-1886). Descriptions of Sponges from the Neighbourhood of Port Phillip Heads, South Australia. Ann. Mag. Nat. Hist., ser. 5, Vol. 17, pp. 431-441; pp. 502-561; Vol. 18, pp. 34-55; pp. 126-149.

—— (7) (1886). Description of a new species (*Aphroceras ramosa*). (in HIGGIN, T., Report on the Porifera of the L. M. B. C. District). Proc. Lit. Phil. Soc. Liverpool, Vol. 40, Appendix.

DENDY, A. (1) (1891). A Monograph of the Victorian Sponges. Part I. The Organisation and Classification of the Calcarea Homocoela, with Descriptions of the Victorian Species. Trans. Roy. Soc. Victoria, Vol. 3, No. 1, pp. 1-82.

—— (2) (1891). Studies on the Comparative Anatomy of Sponges. III. On the Anatomy of *Grantia labyrinthica*, CARTER, and the so-called family Teichonidae. Quart. Journ. Micros. Sci. (n. s.) Vol. 32, pp. 1-39.

—— (3) (1892). Preliminary Account of *Synute pulchella*, a new Genus and Species of

Calcareous Sponges. Proc. Roy. Soc. Victoria, (n. s.) Vol. 4, pp. 1–6.

—— (4) (1892). Synopsis of the Australian Calcarea Heterocoela, with a proposed Classification of the group, and Descriptions of some new Genera and Species. Proc. Roy. Soc. Victoria, (n. s.) Vol. 5, pp. 69–116.

—— (5) (1892). On a new Species of *Leucosolenia* from Port Phillip Heads. Proc. Roy. Soc. Victoria, (n. s.) Vol. 5, pp. 178–180.

—— (6) (1893). Studies on the Comparative Anatomy of Sponges. V. Observations on the Structure and Classification of the Calcarea Heterocoela. Quart. Journ. Micros. Sci., (n. s.) Vol. 35, pp. 159–257, Pl. 24.

—— (7) (1893). Studies on the Comparative Anatomy of Sponges. VI. On the Anatomy and Relationship of *Lelapia australis*, a living representative of the fossil Pharetrones. Quart. Journ. Micros. Sci., (n. s.) Vol. 36, pp. 127–142, Pl. 13.

—— (8) (1905). Report on the Sponges collected by Prof. HERDMAN at Ceylon in 1902. Reports on the Pearl Oyster Fish. Gulf Manaar, Vol. 3, pp. 59–246.

—— (9) (1913). Report on the Calcareous Sponges collected by the Sealark Expedition in the Indian Ocean. Trans. Linn. Soc. London, Zool., Vol. 16, pp. 1–29.

—— (10) (1914). On the Occurrence of *Aphroceras* (*Leucandra*) *ciliarensis* STEPHENS near Plymouth. Journ. Marine Biol. Assoc. United King., Vol. 10, No. 2, pp. 258–259.

—— (11) (1915). Report on the Calcareous Sponges collected by Mr. JAMES HORNELL at Okhamandal in Kattiawar in 1905–06. Report to the Gover. Baroda Marine Zool. Okhamandal in Kattiawar, Part II.

—— (12) (1918). Calcareous Sponges. Australasian Antarctic Expedition 1911–14. Scientific Reports, ser. C. Zool. Bot., Vol. 6, Part I.

—— (13) (1924). British Antarctic ("Terra Nova") Expedition, 1910. Nat. Hist. Rep. Zool., Vol. 16, No. 3.

—— (14) (1926). On the Origin, Growth, and Arrangement of Sponge-spicules: A study in Symbiosis. Quart. Journ. Micros. Sci., Vol. 70, Part I, pp. 1–74, Pls. 1–3.

DENDY, A. and FREDERICK, L. M. (1924). On a Collection of Sponges from the Abrolhos Islands, Western Australia. Journ. Linn. Soc. London, Zool., Vol. 35, pp. 477–518.

DENDY, A. and NICHOLSON, J. W. (1917). On the Influence of Vibrations upon the Form of Certain Sponge-Spicules. Proc. Roy. Soc., B. Vol. 89, pp. 573–587.

DENDY, A. and ROW, R. W. H. (1913). The Classification and Phylogeny of the Calcareous Sponges, with a Reference List of all the described species, systematically arranged. Proc. Zool. Soc. London, pp. 704–813.

DÖDERLEIN, L. (1) (1892). Description of *Petrostroma schulzei*, ng. et sp. of Calcarea, representing a new oder Lithones. Verhandl. deutsch. Zool. Ges., Vol. 2, pp. 143–145.

—— (2) (1897). Über die Lithonina, eine neue Gruppe von Kalkschwämmen. Zool. Jahrb. Syst. Abth., Bd. 10, pp. 16–32.

DUNCAN, P. M. (1880). On a parasitic Sponge of the Order Calcarea (*Möbiusispongia paracitica*). Journ. Roy. Micros. Soc., Vol. 3, pp. 377–393.

EBNER, V. von (1) (1887). *Amphoriscus buccichi*, n. sp. Zool. Jahrb., Vol. 2, pp. 881–982.

—— (2) (1887). Über den feineren Bau der Skelettheile der Kalkschwämme nebst Bemerkungen über Kalkskelete überhaupt. Sitz. kais. Akad. wiss., Abt. I, Bd. 95, pp. 1–95, Pls. I–IV.

FLLIS, J. and SOLANDER, D. (1786). Natural History of many curious and uncommon Zoophytes collected from various parts of the Globe. London.

Fabricius, O. (1780). Fauna Groenlandica. Hafniae et Lipsiae.

Fristedt, N. (1887). Sponges from the Atlantic and Arctic Oceans, and the Behring Sea (Vega Expedition). Vega Exped. Ventensk. Iakttag, Vol. 4, pp. 401–471.

Gibson, R. J. H. (1885). On a new species of *Sycandra* (*aspera*). First Report on the Fauna of Liverpool Bay, pp. 365–367.

Grant, R. E. (1) (1825–1826). Observations and Experiments on the Structure and Functions of the Sponges. Edinburgh Pilos. Journ., Vol. 13, pp. 94–107; 333–346; Vol. 14, pp. 113–124.

—— (2) (1826). Remarks on the Structure of some Calcareous Sponges. Edinburgh Pilos. Journ., Vol. 1, pp. 166–170.

Gray, J. E. (1) (1858). Description of *Aphroceras*, a new genus of Calcareous Spongiadae from Hongkong. Proc. Zool. Soc. London, pp. 113–114.

—— (2) (1867). Notes on the Arrangement of Sponges with Descriptions of some new Genera. Proc. Zool. Soc. London, pp. 492–558.

Haeckel, E. (1) (1870). Prodromus eines Systems der Kalkschwämme. Jenai. Zeitschr., Vol. 5, pp. 236–254.

—— (2) (1872). Die Kalkschwämme, eine Monographie. Berlin.

Hammer, F. (1908). Neue Beiträge zur Kenntnis der Histologie und Entwicklung von *Sycon raphanus*. Arch. Biontol., Bd. 2, pp. 289–334.

Hanitsch, R. (1) (1889). Second Report on the Porifera of the L. M. B. C. District. Proc. Biol. Soc. Liverpool, Vol. 3, pp. 155–173, Pls. V–VII.

—— (2) (1890). Third Report on the Porifera of the L. M. B. C. District. Proc. Liverpool Biol. Soc., Vol. 4, pp. 192–228.

—— (3) (1894). *Amphiute*, eine neue Gattung heterocoeler Kalkschwämme. Zool. Anz., Vol. 17, pp. 433.

—— (4) (1895). Notes on a Collection of Sponges from the West Coast of Portugal. Trans. Liverpool Biol. Soc., Vol. 9, pp. 205–219.

Hara, J. (1894). On a new Species of Calcareous Sponge, *Lelapia nipponica*. Zool. Mag. Tokyo, Vol. 6, pp. 369–370, Pl. VIII.

Hernandez, F., F. (1) (1916). Esponjas Espanolas. Fauna del mediterraneo occidental. Trabajos del Museo Nacional de Ciencias Naturales, ser. Zool., Num. 27, pp. 1–52.

—— (2) (1918). Esponjas del Litoral de Asturias. Trabajos del Museo Nacional de Ciencias Naturales ser. Zool., Num. 36, pp. 1–39.

—— (3) (1933). Sobre algunas esponjas de Marin (Clicia). Boletin Soc. Española Hist. Nat., Tomo 33, pp. 347–358, Pls. 22–25.

Higgin, T. (1886). Porifera of the L. M. B. C. District. First Report upon the Fauna of Liverpool Bay. Liverpool Marine Biol. Comm. Rep., No. 1, pp. 72–94.

Hinde, C. J. (1900). On Some Remarkable Calcisponges from the Eocene Strata of Victoria (Australia). Quart. Journ. Geol. Soc., Vol. 56, pp. 50–66.

Hôzawa, S. (1) (1916). On some Japanese Calcareous Sponges belonging to the Family Heteropiidae. Journ. Coll. Sci. Imp. Univ. Tokyo, Vol. 38, Art 5, Pls. I, II.

—— (2) (1918). Report on the Calcareous Sponges collected by the U. S. Fisheries Steamer "Albatross" in the Northwestern Pacific during 1906. Proc. U. S. Nat. Mus., Vol. 54, pp. 525–556, Pls. 84, 85.

—— (3) (1923). On a new Genus of Calcareous Sponges. Annot. Zool. Japon., Vol. 10, art. 18, pp. 183–190, Pl. I.

—— (4) (1928). Report of the Biological Survey of Mutsu Bay. Calcarea of Mutsu Bay.

Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 3, pp. 219–221, Pl. I.

HÔZAWA, S. (5) (1929). Studies on the Calcareous Sponges of Japan. Journ. Fac. Sci. Imp. Univ. Tokyo, Sect. 4, Zool., Vol. 1, Part 5, pp. 277–389, Pls. 1–12.

—— (6) (1933). Report on the Calcareous Sponges obtained by the Survey of the Continental Shelf bordering on Japan. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 8, pp. 1–20, Pl. I.

—— (7) (1940). On Some Calcareous Sponges from Japan. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 15, No. 1, pp. 29–58, Pls. IV, V.

—— (8) (1940). Report on the Calcareous Sponges obtained by the Zoological Institute and Museum of Hamburg. Part I. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 15, No. 2, pp. 131–163, Pls. VI, VII.

HÔZAWA, S. and TANITA, S. (1941). The Fauna of Akkeshi Bay. XII. Calcarea. Journ. Fac. Sci. Hokkaidô Imp. Univ. Zool., Vol. 7, No. 4, pp. 421–429.

JAMES-CLARK, H. (1869). On the Spongiae Ciliatae as Infusoria Flagellata; or Observations on the Structure, Animality, and Relationships of *Leucosolenia botryoides* BDK. Mem. Boston Soc. Nat. Hist., Vol. 1, pp. 305–340.

JENKIN, C. F. (1) (1908). The Marine Fauna of Zanzibar and British East Africa, from Collections made by CYRIL CROSSLAND, M. A., in the years 1901 & 1902. The Calcareous Sponges. Proc. Zool. Soc. London, pp. 434–456.

—— (2) (1908). The Calcarea of the National Antarctic Expedition. Nat. Hist. Rep., Vol. 4.

JOHNSTON, G. (1842). A History of British Sponges and Lithophytes. Edinburgh, 1842.

KIRK, H. B. (1) (1893). Contribution to a Knowledge of the New Zealand Sponges. Trans. New Zealand Instit., Vol. 26, pp. 175–179.

—— (2) (1894). Further Contribution to a Knowledge of the New Zealand Sponges. Trans. New Zealand Instit., Vol. 27, pp. 287–392.

—— (3) (1895). New Zealand Sponges. Third Paper. Trans. New Zealand Instit., Vol. 28, pp. 205–210.

—— (4) (1897). Notes on New Zealand Sponges. Fourth Paper. Trans. New Zealand Instit., Vol. 30, pp. 313–316.

KIRKPATRICK, R. (1) (1900). Description of Sponges from Funafuti. Ann. Mag. Nat. Hist., ser. 7, Vol. 6, pp. 345–362.

—— (2) (1908). On two new Genera of recent Pharetronid Sponges. Ann. Mag. Nat. Hist. ser. 8, Vol. 2, pp. 503–514.

—— (3) (1910). On a remarkable Pharetronid Sponge from Christmas Island. Proc. Roy. Soc. London, Vol. 83, pp. 124–133.

—— (4) (1911). On a new Lithonine Sponge from Christmas Island. Ann. Mag. Nat. Hist. ser. 8, Vol. 8, pp. 177–179.

—— (5) (1911). On *Merlia normani*, a sponge with a silicious and calcareous skeleton. Quart. Journ. Micros. Sci. (n. s.) Vol. 56, pp. 657–702.

—— (6) (1912). Note on *Astrosclera willeyana*, LISTER. Proc. Roy. Soc. London, Vol. 64, pp. 579–580.

KÖLLIKER, A. von (1864). Icones Histologicae, oder Atlas der vergleichenden Gewebelehre. I. Der feineren Bau der Protozoen. Leipzig.

LACKSCHEWITZ, P. (1886). Über die Kalkschwämme Menorcas. Zool. Jahrb., Vol. 1, pp. 297–310.

LAMBE, L. M. (1) (1893). Sponges from the Pacific Coast of Canada. Trans. Roy. Soc. Canada, pp. 25–43.

LAMBE, L. M. (2) (1896). Sponges from the Atlantic Coast of Canada. Trans. Roy. Soc. Canada, ser. 2, Vol. 2, pp. 181–211.

—— (3) (1900). Sponges from the Coasts of North-eastern Canada and Greenland. Trans. Roy. Soc. Canada, ser. 2, Vol. 6, Sec. 4, pp. 19–48.

—— (4) (1900). Description of a new Species of Calcareous Sponge from Vancouver Island, B. C. Ottawa Naturalist, Vol. 13, No. 11, pp. 261–263.

—— (5) (1900). Catalogue of the Recent Marine Sponges of Canada and Alaska. Ottawa Naturalist, Vol. 14, No. 9, pp. 153–172.

LAUBENFELS, M. W. (1932). The Marine and Fresh-water Sponges of California. Proc. U. S. Nat. Hist. Mus., Vol. 18, Art. 4, pp. 1–140.

LENDENFELD, R. von (1) (1885). The Homocoela of Australia and the new family Homodermidae. Proc. Linn. Soc. New South Wales, Vol. 9, pp. 896–907.

—— (2) (1885). A Monograph of the Australian Sponges. Part III. The Calcispongiae. Proc. Linn. Soc. New South wales, Vol. 9, pp. 1083–1150.

—— (3) (1891). Das System der Kalkshwämme (Vorl. Mitth.) Sitzungesbericht. Kais. Akad. wiss. Wien, Mathem.-natur. Classe Bd. C. Abth. 1, pp. 1–16.

—— (4) (1892). Die Spongien der Adria. I. Die Kalkschwämme. Zeit. wiss. Zool., Bd. 53, Heft 2, pp. 185–321, Pls. 8–15; Heft 3, pp. 361–463.

LIEBERKÜHN, N. (1859). Neue Beiträge zur Anatomie der Spongien. MÜLLER's Archiv. 1859, pp. 353–382; pp. 515–530.

LISTER, J. J. (1900). *Astrosclera willeyana*, the Type of a new family of Sponges. A WILLEY's Zoological Results, Part IV, Cambridge.

LUNDBECK, W. (1909). The Porifera of East Greenland. Meddel. om Grönland, Vol. 29, pp. 423–464.

MAYER, P. (1879). *Wagnerella borealis*. Zool. Anz., Vol. 2, pp. 357–358.

MEREJKOWSKY, C. (1878). On *Wagnerella*, a new genus of Sponge nearly allied to the *Physemaria* of ERNST HAECKEL. Ann. Mag. Nat. ser. 5, Vol. 1, pp. 70–77.

MICHLUCHO-MACLAY, N. de (1) (1868). Beiträge zur Kenntniss der Spongien. I. Über *Guancha blanca*, einen neuen Kalkschwamm. Jena. Zeits., Vol. 4, pp. 221–240.

—— (2) (1870). Über einige Schwämme des nordlischen stillen Oceans und des Eismeeres, welche im Zoologischen Museum der Kaiserlichen Akademie der Wissenschaften in St. Pétersburg aufgestellt sind; ein Beitrag zur Morphologie und Verbreitung der Spongien. Mémo. l'Académie Sci. St. Pètersburg, Vol. 15, No. 3.

MINCHIN, E. A. (1) (1892). Note on a Sieve-like Membrane across the Oscula of a Species of *Leucosolenia*, with some Observations on the History of the Sponge. Quart. Journ. Micros. Sci., 1892, pp. 1–24, Pls. X, XI.

—— (2) (1892). The Oscula and Anatomy of *Leucosolenia clathrus*, O. S. Quart. Journ. Micros. Sci., pp. 477–495, Pl. 29.

—— (3) (1896). Suggestions for a Natural Classification of the Asconidae. Ann. Mag. Nat. Hist. ser. 6, Vol. 18, pp. 349–362.

—— (4) (1897). Materials for a Monograph of the Ascons. I. On the Origin and Growth of the Triradiate and Quadriradiate Spicules in the family Clathrinidae. Quart. Journ. Micros. Sci. (n. s.) Vol. 40, pp. 469–588.

—— (5) (1897). *Ascandra* or *Homandra*? A Test Case for the Rules of Zoological Nomenclature. Zool. Anz., Bd. 20, No. 524, pp. 49–50.

—— (6) (1900). The Porifera. Lankester's Treatie on Zoology, Part 2, Chap. 3.

—— (7) (1905). On the Sponge *Leucosolenia contorta* BOWERBANK, *Ascandra contorta* HAECKEL, and *Ascetta spinosa* LENDENFELD. Proc. Zool. Soc. London, Vol. 2, pp. 1–20, Pl. 1.

—— (8) (1905). The Characters and Synonymy of the British Species of Sponges of the Genus *Leucosolenia*. Proc. Zool. Soc. London, Vol. 2, pp. 349–396.

—— (9) (1908). Materials for a Monogragh of the Ascons. II. The Formation of Spicules in the Genus *Leucosolenia*, with some Notos on the Histology of the Sponges. Quart. Journ. Micros. Sci., Vol. 52, Part 3, pp. 301–355, Pls. 17–21.

—— (10) (1909). The Relation of the Flagellum to the Nucleus in the Collar-cells of Calcareous Sponges. Zool. Anz., Bd. 35, pp. 227–231.

MONTAGU, G. (1812). An Essay on Sponges, with Descriptions of all the Species that have been discovered on the Coast of Great Britain. Memoirs of the Wernerian Soc. Edinburgh, Vol. 2, pp. 67–122.

POLÉJAEFF, N. (1888). The Calcarea. Report on the Scientific Results of the Voyage of H. M. S. "Challenger". Zoology, Vol. 8.

PREIWISCH, J. (1904). Kalkschwämme aus dem Pacific. Ergebnisse einer Reise nach dem Pacific, Schauinsland 1896–1897. Zool. Jahrb. Syst-abth., Bd. 19, pp. 9–26.

PRIEST, B. W. (1887). On the Calcarea. Journ. Quekett Micro. Club, Vol. 3, ser. 2, pp. 99–107, Pls. 7, 8.

QUOY, J. R. C. et GAIMARD, P. (1833). Voyage de l'Astrolabe. Zool., Vol. 4, Paris.

RIDLEY, S. O. (1) (1881). Spongida collected during the Expedition of H. M. S. Alert in the Straits of Magellan and on the Coasts of Patagonia. Proc. Zool. Soc. London, pp. 107–137.

—— (2) (1884). "Spongida". Reports on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H. M. S. 'Alert', 1881–1882. pp. 366–482; pp. 582–660, London.

RISSO, A. (1826). Historie Naturelle des principales Productions de l'Europe Méridionale, et particulièrement de celles des Envirous de Nice, & c. Vol. V, Paris, 1826.

ROW, R. W. H. (1909). Reports on the Marine Biology of the Sudanese Red Sea. XIX. Report on the Sponge collected by Mr. CYRIL CROSSLAND in 1904–1905. Part I. Calcarea. Journ. Linn. Soc. London, Zool., Vol. 31, pp. 182–214.

ROW, R. W. H. and HÔZAWA, S. (1931). Report on the Calcarea obtained by the Hamburg South-West Australian Expedition of 1905. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 6, No. 4, pp. 727–809, Pls. 19–21.

SASAKI, N. (1941). On the Changes Occurring in Various Parts of the Body, Especially in the Spicules in Accordance with the Increase of Body Length in the Case of the Calcareous Sponges, *Sycon okadai* HÔZAWA. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 16, No. 4, pp. 265–382.

SCHMIDT, O. (1) (1862). Die Spongien des Adriatischen Meeres. Leipzig.

—— (2) (1864). Supplement der Spongien des Adriatischen Meeres, enthaltend die Histologie und systematische Ergänzungen. Leipzig.

—— (3) (1868). Die Spongien der Küste von Algier, mit Nachträgen zu den Spongien des Adriatischen Meeres. (Drittes Supplement). Leipzig.

—— (4) (1870). Grundzüge einer Spongien-Fauna des Atlantischen Gebiets. Leipzig.

SCHUFFNER, O. (1877). Beschreibung einiger neuer Kalkschwämme. Jena. Zeitsch., Vol. 11, pp. 403–433.

SCHULZE, F. E. (1875). Über den Bau und die Entwicklung von *Sycandra raphanus* HAECKEL. Zeit. wiss. Zool. Suppl., Vol. 25, pp. 247–280.

SHAW, M. E. (1927). On a Collection of Sponges from Maria Island, Tasmania. Proc. Zool. Soc. London, No. 28, pp. 419–440.

Spek, J. (1938). Studien über die Polarität der Larven der Kalkschwämme. Protoplasma, Bd. 30, Heft 3, pp. 352–372.

Stephens, J. (1912). Clare Island Survey. Part 59. Marine Porifera. Proc. Ray. Irish Acad., Vol. 31, No. 59.

Tanita, S. (1) (1939). Two New Calcarea obtained from Sasebo, Japan. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 14, No. 2, pp. 319–326.

——— (2) (1940). Calcareous Sponges of Matsushima Bay. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 15, No. 2 pp. 165–177, Pl. 8.

——— (3) (1941). Report of the Biological Survey of Mutsu Bay. 35. Studies on the Calcarea of Mutsu Bay. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 16, No. 1, pp. 1–8, Pl. 1.

——— (4) (1941). Calcareous Sponges obtained from Onagawa Bay and its Vicinity. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 16, No. 3, pp. 263–282, Pl. 17.

——— (5) (1942). Calcareous Sponges collected in Kantô District, Japan. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 17, No. 1, pp. 17–69, Pls. 2–4.

——— (6) (1942). Key to all the described Species of the Genus *Leucosolenia* and their Distribution. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 17, No. 1, pp. 71–92.

——— (7) (1942). Report on the Calcareous Sponges obtained by the Zoological Institute and Museum of Hamburg. Part II. Sci. Rep. Tôhoku Imp. Univ. Biol., Vol. 17, No. 2, pp. 105–135, Pls. 6, 7.

Thacker, A. G. (1908). On Collections of the Cape Verde Islands Fauna made by Cyril Crossland, M.A., from July to September 1904. The Calcareous Sponges. Proc. Zool. Soc. London, pp. 757–782, Pl. 40.

Topsent, E. (1) (1907). Eponges calcaries recueillis par le Francais dans l'Antarctique (Expédition du Dr. Charcot). Bull. Mus. Hist. Nat. Paris, pp. 539–544.

——— (2) (1936). Etude sur des *Leucosolenia*. Bull. L'Inst. Océano., No. 711, pp. 1–47.

Ulrich, E. O. (1869). Preliminary Description of new Lower Silurian Sponges. American Geol., Vol. 3, pp. 233–248.

Urban, F. (1) (1902). *Rhabdodermella nuttingi*, Nov. gen. et. nov. sp. Zeit. wiss. Zool., Bd. 71, pp. 268–275.

——— (2) (1905). Kalifornische Kalkschwämme. Arch. f. Naturgesch. Jahrgang 72, Bd. 1, pp. 33–76.

——— (3) (1908). Die Kalkschwämme der deutschen Tiefsee-Expedition. Zool. Anz., Bd. 33, pp. 247–252.

——— (4) (1909). Die Calcarea. Wissensch. Ergeb. deutschen Tiefsee-Exped. (Valdivia), Bd. 19, Jena.

Verrill, A. E. (1873). Exploration of Casco Bay by the U. S. Fish Commission in 1873. Proc. Amer. Assoc. Advance Sci., Part 2, pp. 340–395.

Vosmaer, G. C. J. (1) (1880). Über *Leucandra aspera* H., nebst allgemeinen Bemerkungen über das Canalsystem der Spongien. Leiden, 1880.

——— (2) (1887). Porifera. Die Klassen und Ordnungen des Thierreichs, wissenschaftlich dargestellt in Wort und Bild.

Zittel, K. A. (1877). Studien über fossile Spongien. III. Monactinellidae, Tetractinellidae, und Calcispongiae. Abhand. Akad. wiss. München, Vol. 13, Part 2, pp. 1–48.

EXPLANATION OF THE PLATES

PLATE XI

Fig. 1. *Leucosolenia blanca* (Michlucho-Maclay) ×2; from Usa, Kôti Prefecture.
Fig. 2. *Leucosolenia coriacea* (Montagu) ×2; from Utimi, Miyazaki Prefecture.
Fig. 3. *Leucosolenia primordialis* (Haeckel) ×1.5; from Tanabe Bay, Wakayama Pref.
Fig. 4. *Leucosolenia protogenes* (Haeckel) ×1.5; from Hosono. Wakayama Prefecture.
Fig. 5. *Leucosolenia stipitata* Dendy ×2; from Takahama, Ehime Prefecture.
Fig. 6. Same ×2; from Naha, Okinawa Prefecture.
Fig. 7. Same ×2; from Toba Bay, Mie Prefecture.
Fig. 8. *Leucosolenia wilsoni* Dendy ×2; from Toba Bay, Mie Prefecture.
Fig. 9. *Leucosolenia kagoshimensis* Hôzawa ×2; from Hayataura, Mie Prefecture.
Fig. 10. *Leucosolenia amitsbo* Hôzawa ×1.5; from Kosikijima, Kagosima Prefecture.

PLATE XII

Fig. 11. *Leucosolenia canariensis* (Michlucho-Maclay) ×1.5; from Wakasa-Takahama, Hukui Prefecture.
Fig. 12. Same ×1.5; from Naha, Okinawa Prefecture.
Fig. 13. *Leucosolenia depressa* Dendy ×1.5; from Naha, Okinawa Prefecture.
Fig. 14. *Leucosolenia gardineri* Dendy ×2; from Tomioka, Kumamoto Prefecture.
Fig. 15. *Leucosolenia minuta*, n. sp. ×2; from Sionomisaki, Wakayama Prefecture.
Fig. 16. *Lecuosolenia atlantica* Thacker ×2; from Naha, Okinawa Prefecture.
Fig. 17. *Leucosolenia australis* Brøndsted ×1.5; from Hamajima, Mie Prefecture.
Fig. 18. *Leucosolenia eleanor* Urban ×1.5; from Sukumo-Ôsima, Kôti Prefecture.
Fig. 19. *Leucosolenia izuensis* Tanita ×2; from Tomioka, Kumamoto Prefecture.
Fig. 20. *Leucosolenia laxa* Kirk ×1.5; from Ago Bay, Mie Prefecture.
Fig. 21. *Leucosolenia pyriformis*, n. sp. ×2; Hayataura. Mie Prefecture.

PLATE XIII

Fig. 22. *Leucosolenia tenera* Tanita, natural size; from Tomioka, Kumamoto Pref.
Fig. 23. *Dendya quadripodifera* Hôzawa ×2; from Hayataura, Mie Prefecture.
Fig. 24. *Dendya triradiata*, n sp. ×2; from Naha, Okinawa Prefecture.
Fig. 25. Same ×2; from Naha, Okinawa Prefecture.
Fig. 26. *Leucetta pyriformis* Dendy ×2; from Naha, Okinawa Prefecture.
Fig. 27. *Leucaltis clathria* Haeckel ×2; from Naha, Okinawa Prefecture.
Fig. 28. *Sycon coronatum* (Ellis and Solander) ×2; from Tomioka, Kumamoto Pref.
Fig. 29. Same ×2; from Tatugusi, Kôti Prefecture.
Fig. 30. *Sycon cylindricum* Tanita ×2; from Toba Bay, Mie Prefecture.
Fig. 31. *Sycon ensiferum* Dendy ×2; from Naha, Okinawa Prefecture.
Fig. 32. *Sycon lendenfeldi* Row and Hôzawa ×2; from Hiuga-Utimi, Miyazaki Pref.
Fig. 33. *Sycon luteolum* Tanita ×2; from Izumo-Kagamura, Simane Prefecture.
Fig. 34. Same ×2; from Tomioka, Kumamoto Prefecture.

PLATE XIV

Fig. 35. *Sycon misakiensis* Hôzawa ×1.5; from Kesennuma, Miyagi Prefecture.
Fig. 36. Same ×2; from Takahama, Ehime Prefecture.
Fig. 37. *Sycon okadai* Hôzawa ×1.5; from Kesennuma, Miyagi Prefecture.
Fig. 38. *Sycon ornatum* Kirk ×2; from Hamajima, Mie Prefecture.
Fig. 39. *Sycon plumosum*, n. sp. ×2; from Palao.
Fig. 40. Same ×2; from Palao.
Fig. 41. *Sycon pulchrum*, n. sp. ×2; from Kosikijima, Kagosima Prefecture.
Fig. 42. *Sycon rotundum* Tanita ×2; from Hiravama, Ehime Prefecture.
Fig. 43. Same ×2; from Mimase, Kôti Prefecture.
Fig. 44. *Grantessa shimeji* Hôzawa ×1.5; from Toba Bay, Mie Prefecture.
Fig. 45. *Grantessa shimoda* Tanita ×2; from Toba Bay, Mie Prefecture.
Fig. 46. Same ×1.5; from Toba Bay, Mie Prefecture.

PLATE XV

Fig. 47. *Grantessa mitsukurii* Hôzawa ×1.5; from Tomioka, Kumamoto Prefecture.
Fig. 48. Same ×1.5; from Kannoura, Kôti Prefecture.
Fig. 49. *Grantessa bifida*, n. sp. ×1.5; from Tanabe Bay, Wakayama Prefecture.
Fig. 50. *Grantessa parva* Tanita ×2; from Owasi Bay, Mie Prefecture.
Fig. 51. *Heteropia striata* Hôzawa ×1.5; from Ago Bay, Mie Prefecture.
Fig. 52. *Vosmaeropsis grisea* Tanita ×2; from Onomiti, Okayama Prefecture.
Fig. 53. *Vosmaeropsis spinosa*, n. sp. ×2; from Tomioka, Kumamoto Prefecture.

PLATE XVI

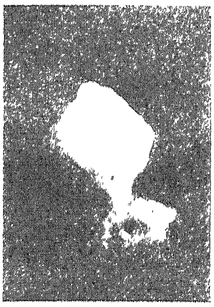
Fig. 54. *Vosmaeropsis maculata* Hôzawa ×1.5; from Mogi, Nagasaki Prefecture.
Fig. 55. Same ×2; from Hososima, Miyazaki Prefecture.
Fig. 56. *Ute armata* Hôzawa ×2; from Kosikijima, Kagosima Prefecture.
Fig. 57. *Anamixilla torresi* Poléjaeff ×2; from Palao.
Fig. 58. Same ×2; from Palao.
Fig. 59. *Leucandra hozawai* Tanita ×2; from Onagawa Bay, Miyagi Prefecture.
Fig. 60. Same, natural size; from Ago Bay, Mie Prefecture.

PLATE XVII

Fig. 61. *Leucandra tropica*, n. sp. ×2; from Palao.
Fig. 62. Same ×2; from Palao.
Fig. 63. *Leucandra abratsbo* Hôzawa ×1.5; From Tanabe Bay, Wakayama Prefecture.
Fig. 64. Same ×2; from Kamikawaguti, Kôti Prefecture.
Fig. 65. *Leucandra globosa*, n. sp. ×1.5; from Sakatahana, Wakayama Prefecture.
Fig. 66. *Leucandra impigra* Tanita ×2; from Tomioka, Kumamoto Prefecture.
Fig. 67. *Leucandra mitsukurii* Hôzawa ×2; from Tomioka, Kumamoto Prefecture.
Fig. 68. *Leucandra multituba* Hôzawa ×2; from Sionomisaki, Wakayama Prefecture.
Fig. 69. Same ×2; from Tomioka, Kumamoto Prefecture.

PLATE XVIII

Fig. 70. *Leucandra dura* Hôzawa ×2; from Simoda, Sizuoka Prefecture.
Fig. 71. Same ×1.5; from Sionomisaki. Wakayama Prefecture.
Fig. 72. *Leucandra ohshimai* Tanita ×1.5; from Tomioka, Kumamoto Prefecture.
Fig. 73. *Leucandra tuberculata* Hôzawa ×1.5; from Tomioka, Kumamoto Prefecture
Fig. 74. Same ×2; from Kitahama, Wakayama Prefecture.
Fig. 75. *Leucandra amakusana*, n. sp. ×2; from Tomioka, Kumamoto Prefecture.
Fig. 76. *Leucandra consolida*, n. sp. ×2; from Naha, Okinawa Prefecture.
Fig. 77. *Leucandra palaoensis*, n. sp. ×2; from Palao.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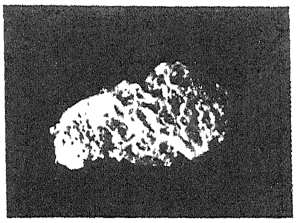

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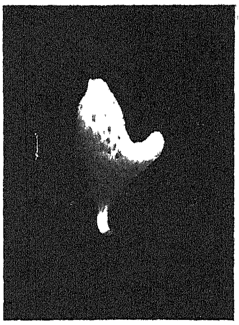

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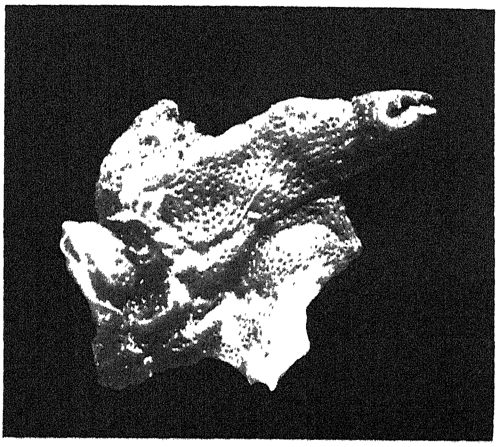

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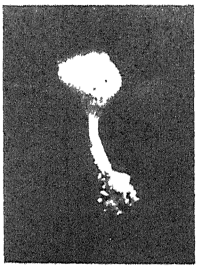

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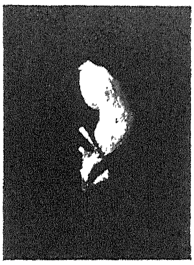

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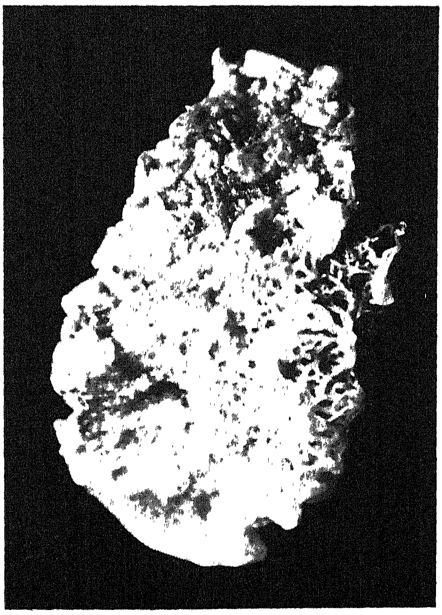

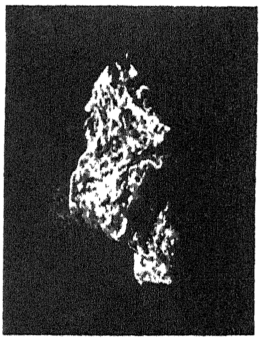
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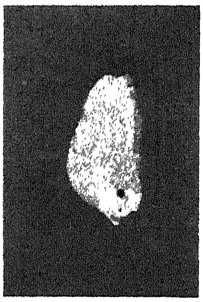
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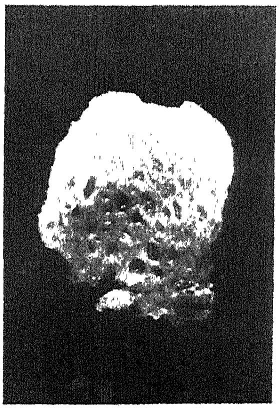
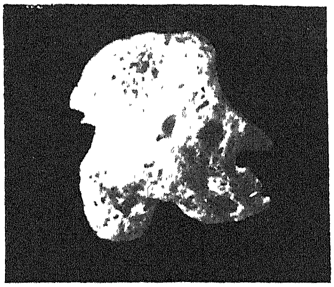


Tanita photo.

S. Tanita: Calcarea of Japan.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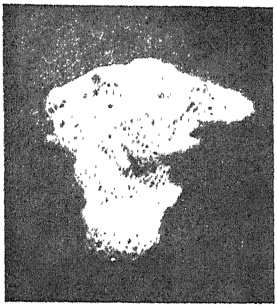
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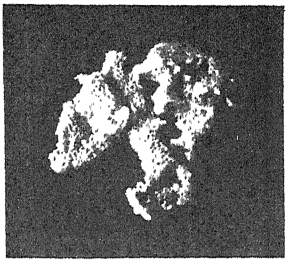
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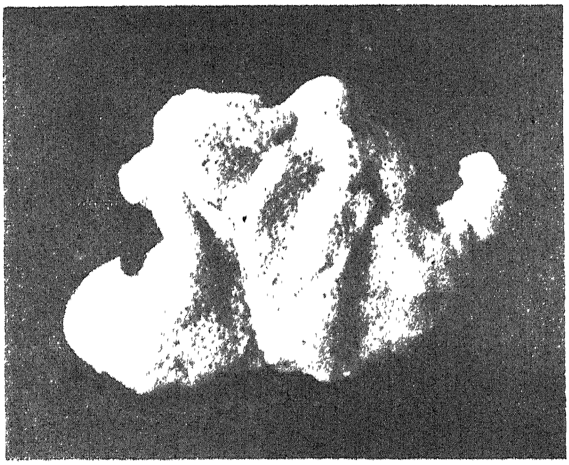
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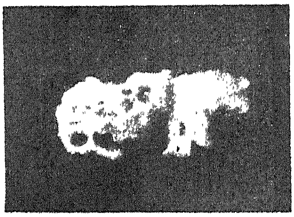
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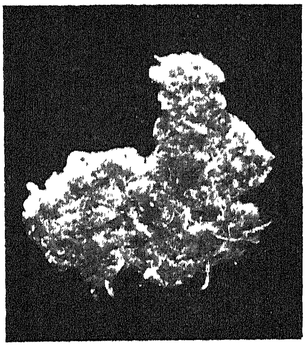
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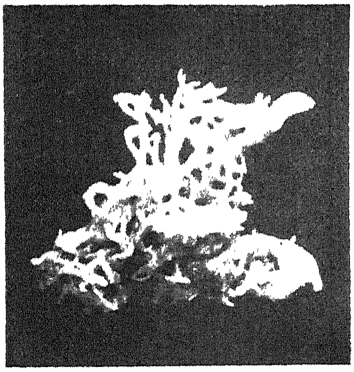
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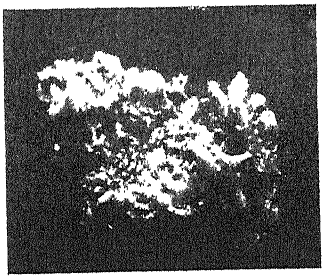
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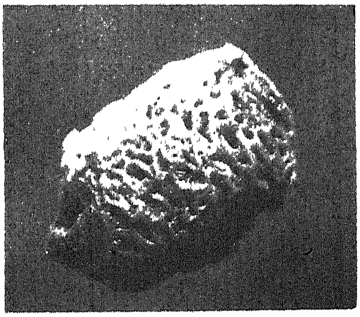
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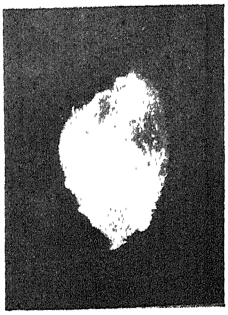
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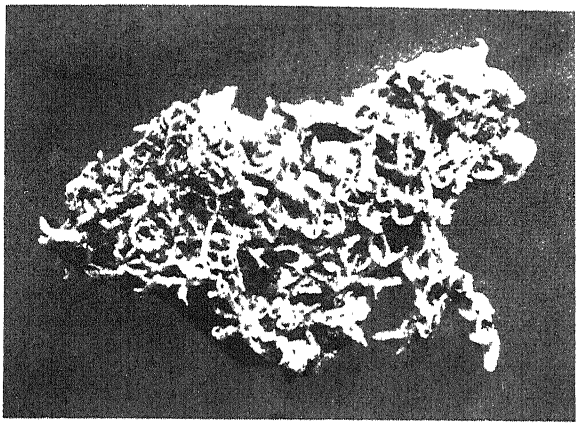
TANITA photo.

S. TANITA: Calcarea of Japan.



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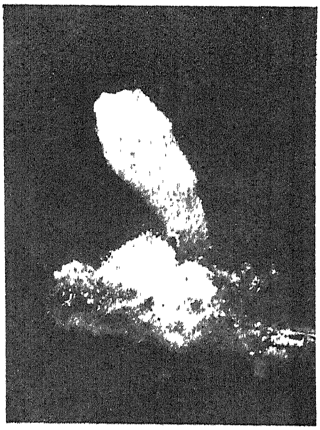

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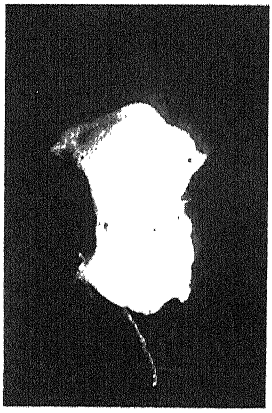

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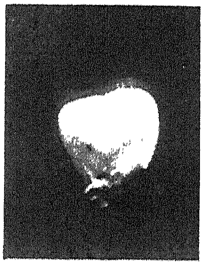

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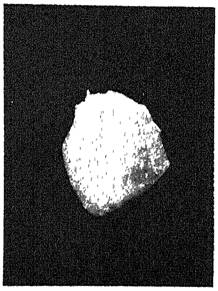

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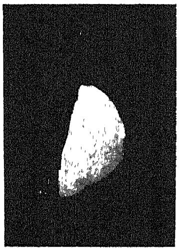

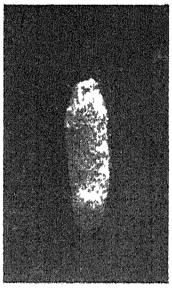

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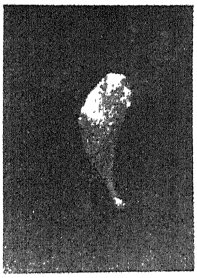

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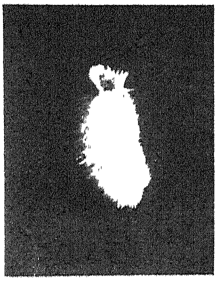

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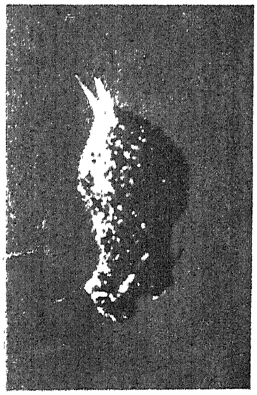

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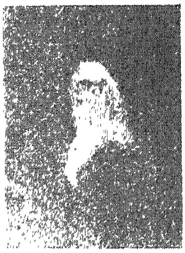

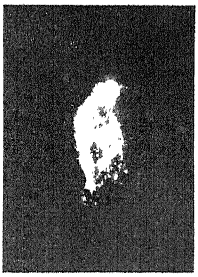

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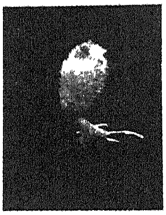

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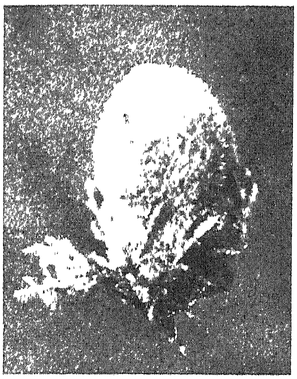
S. TANITA: Calcarea of Japan.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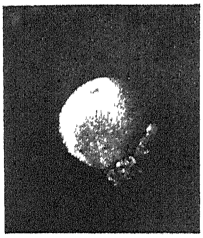
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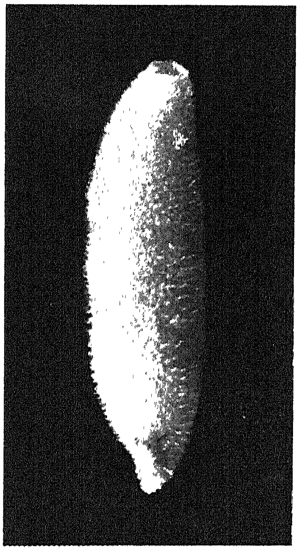
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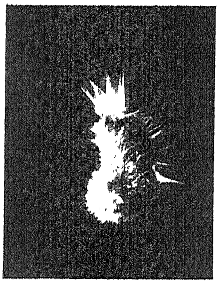
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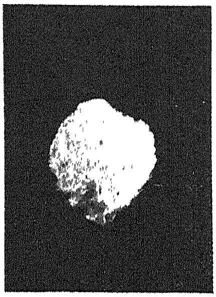
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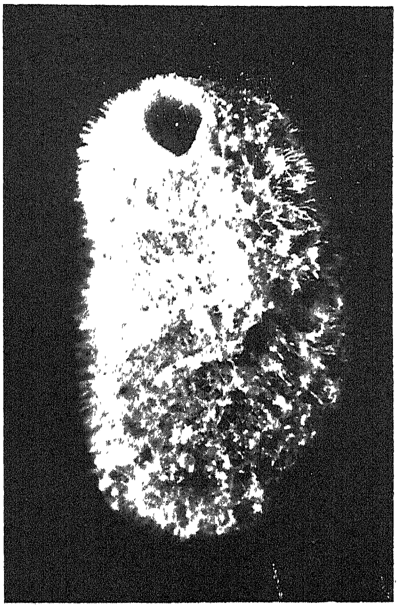
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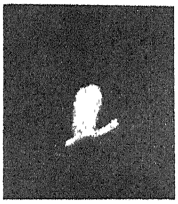
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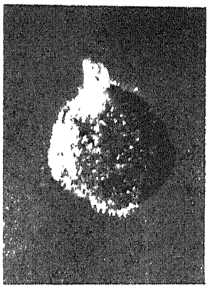
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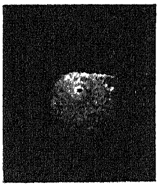
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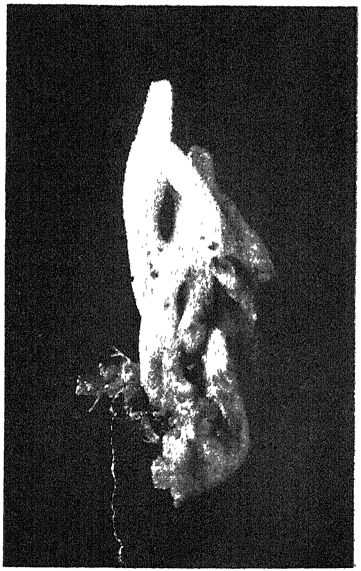
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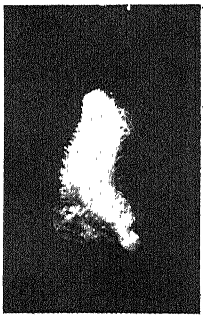
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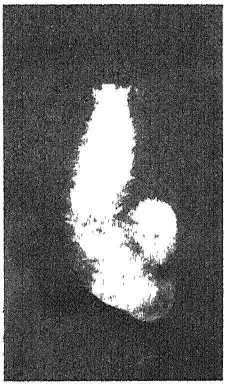
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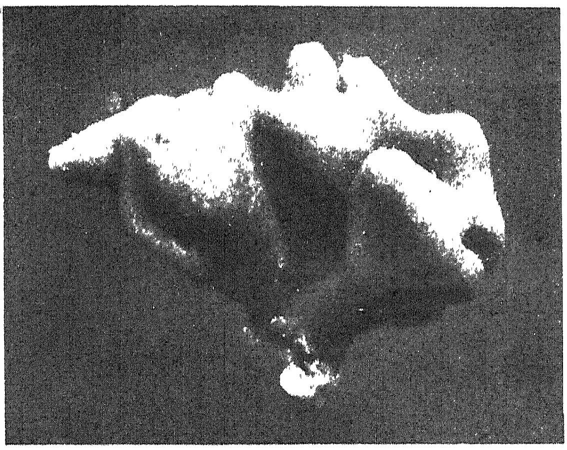
S. TANITA: Calcarea of Japan.



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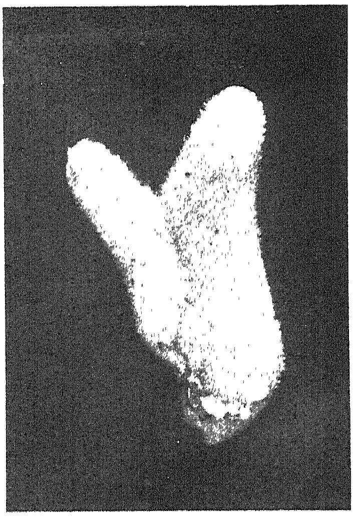

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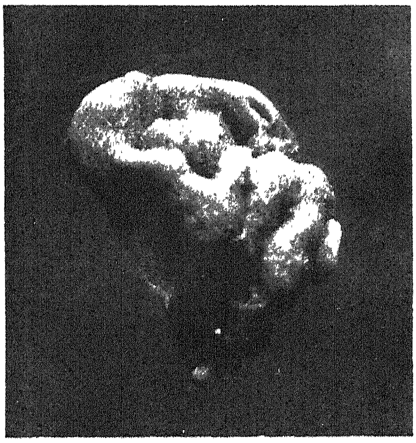

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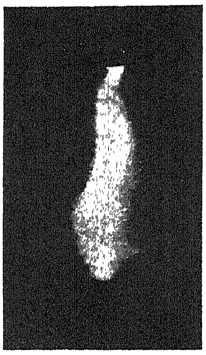

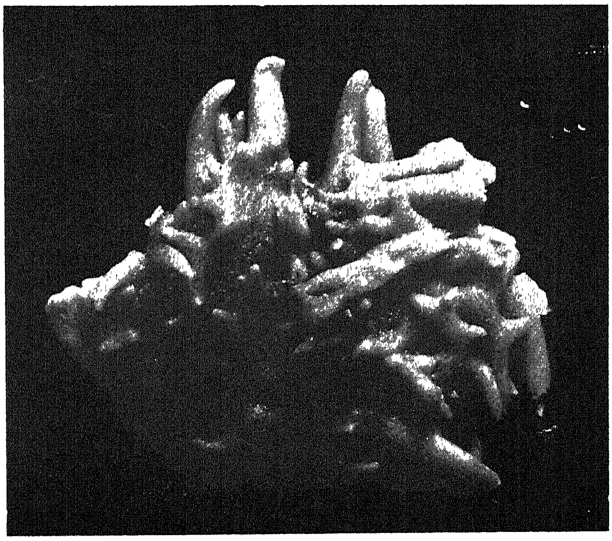

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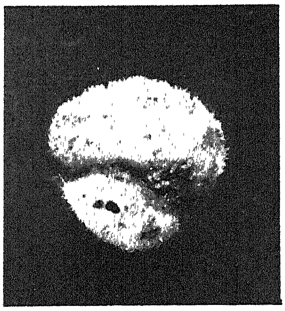

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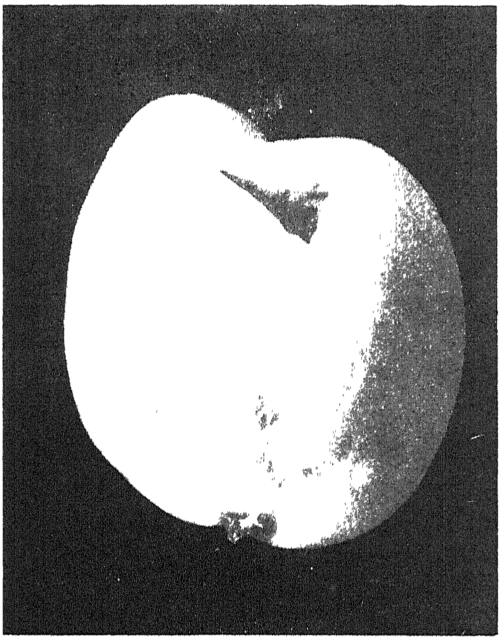
S. TANITA: Calcarea of Japan.



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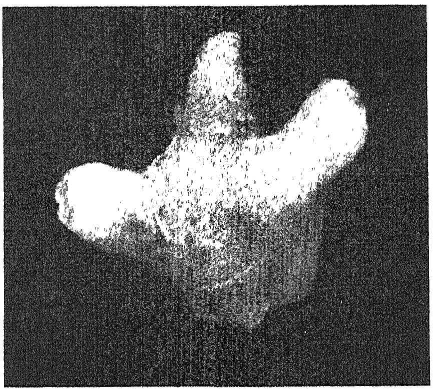

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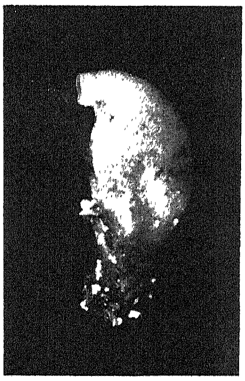

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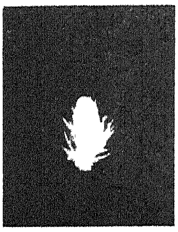

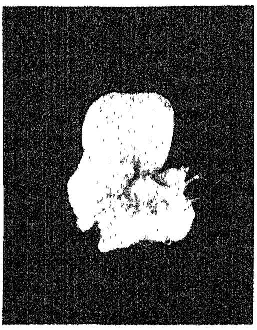

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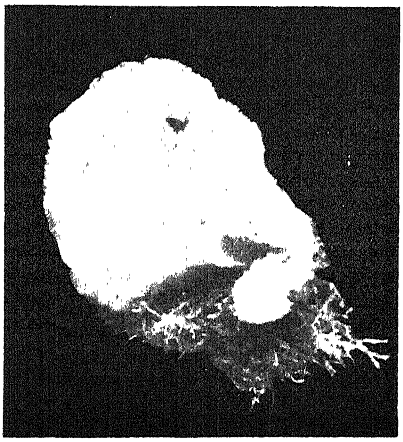

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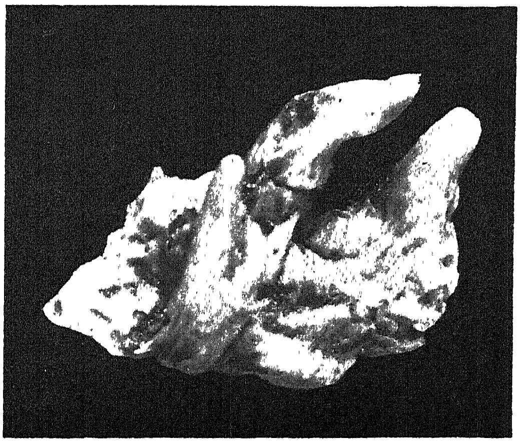

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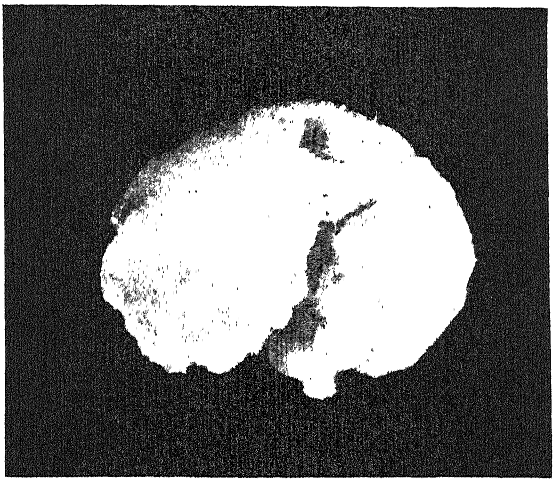

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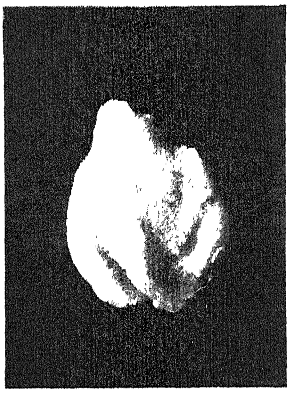

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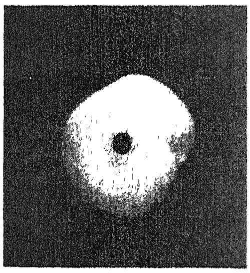

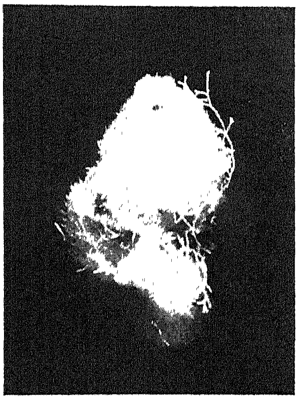

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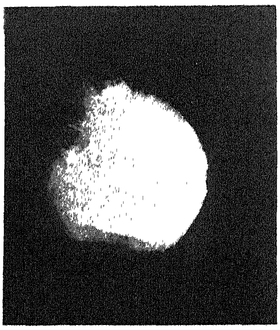

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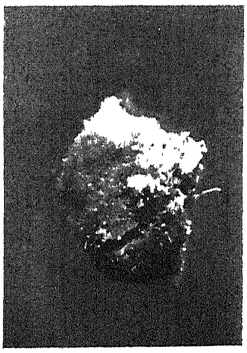

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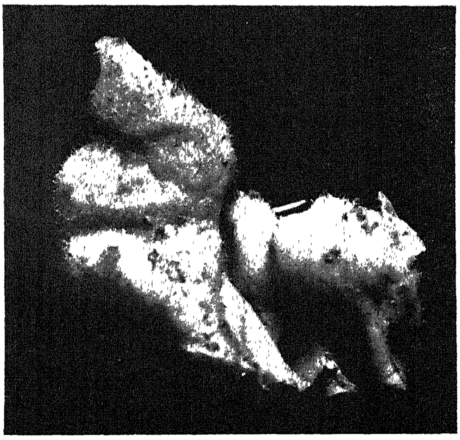

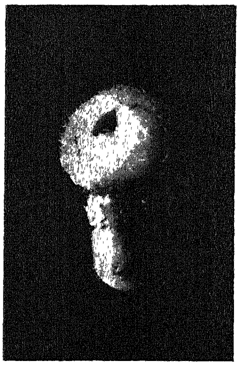

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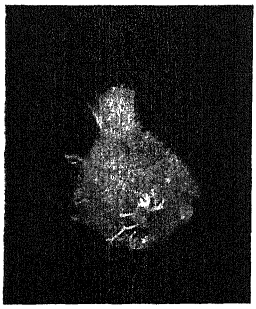

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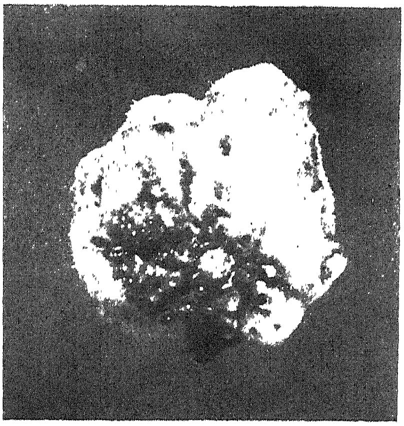
S. TANITA: Calcarea of Japan.



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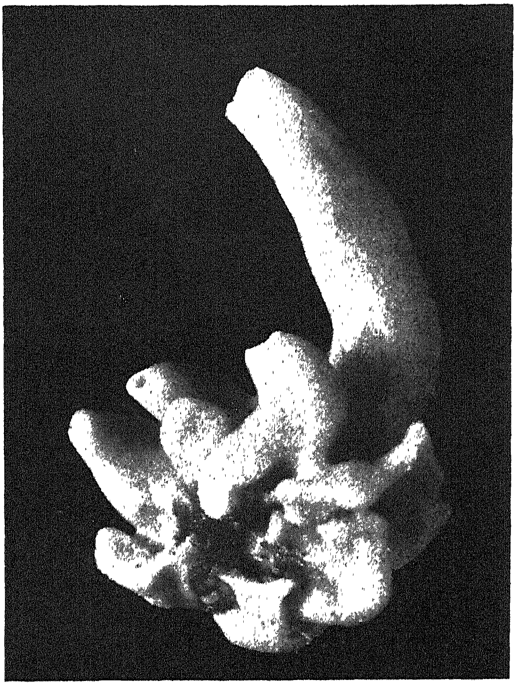

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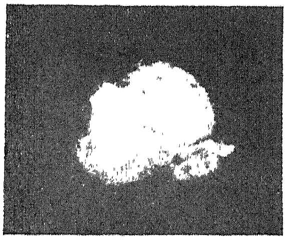

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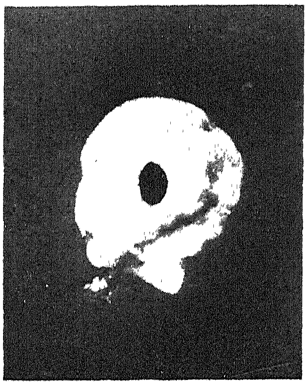

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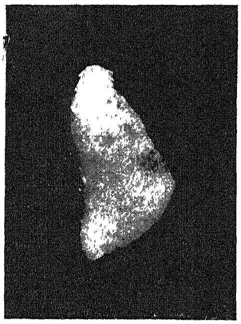

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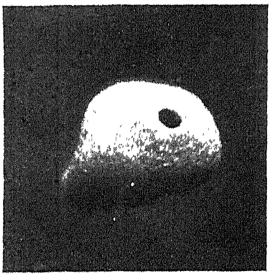

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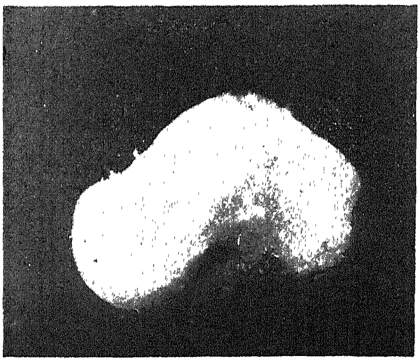

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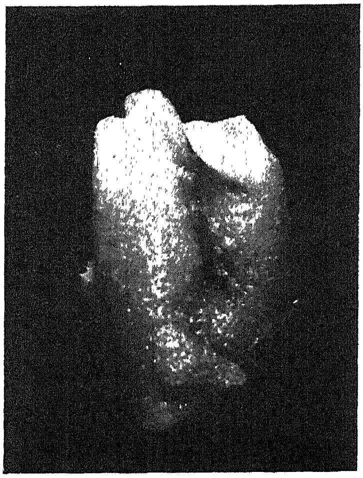

77

TANITA photo.

DIAGNOSTIC CHARACTERS OF POLLEN GRAINS[1]

BY

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(With Pls. XIX XX)

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INTRODUCTION

During the recent two and a half decades which have elapsed since the introduction of the pollen analytical method, there have been marked developments in the knowledge of the extinct vegetations, which throws light upon the climatic changes in the past. In connection with it, a body of accounts on the pollen-grain characters for use in the pollen analysis were published by many workers, such as DOKTUROWSKY and KUDRJASCHOW (1923), ERDTMAN (1924, 1936), RUDOLPH and FIRBAS (1925), MEINKE (1927), STARK (1927), SEARS (1930), WASSINK (1932), JIMBÔ (1933), YAMAZAKI (1933), KIRCHHEIMER (1934), POTONIÉ (1934), RUDOLPH (1935), HANSEN (1939 *a*), CAIN (1940), etc.

It dates back, however, to the seventeenth century that the phylogenetic value of the pollen-grain characters was first noticed, and by the beginning of this century the following main facts concerning the correlation of pollen characters with the systematic relationship have already been well established: (1) The pollen grains of the related species are generally similar, and the different species of a genus can hardly be distinguished from each other by their forms. But some families produce the pollen of more than a single type, and on the other hand unrelated plants occasionally have the similar pollen. (2) Broadly speaking, the pollen grains of gymnosperms and monocotyledons have an exine of simple structure, while those of dicotyledons a more complicated exine. Recently a great progress in this field was attained by the extensive work of WODEHOUSE (1935), who gave in his elaborate book an exhaustive review of the literature and a minute elucidation of every kind of pollen, in which its phylogenetic relationship is brought out.

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[1] Contributions from the Mt. Hakkôda Botanical Laboratory. No. 26.

From the viewpoint of the pollen analytical study, the prominent features of the exine alone are considered, apart from phylogenetic questions, since the fossil pollen found in peat and related materials is represented exclusively by the persistent exine[1].

Although the distinction between species within a genus is believed to be impossible in general, STARK (1927), TRELA (1928), HÖRMANN (1929), BERTSCH (1931), ERDTMAN (1936), HANSEN (1938, 1939 *a*, *b*), CRANWELL (1939)[2], WILSON and KOSANKE (1940)[3], CAIN (1940), HEIMSCH (1940), etc. have claimed to have succeeded in identifying individual species of various genera, such as *Pinus*, *Picea*, *Abies*, *Tsuga*, *Alnus*, *Betula*, *Tilia*, *Nothofagus*, *Fraxinus*, *Rhus*, etc. In the scope of the writer's investigation, however, a definite specific determination is impossible in any of those and other genera, except that our two common birches, *Betula latifolia* and *B. Ermanii* var. *communis*, may be distinguished by the size of pollen[4], and that the pollen of *Magnolia obovata* is by far larger than that of other two species of the same genus. It is obvious that such an attempt to identify the species will encounter more difficulties in the practice of pollen analysis, since the fossil pollen is apt to occur in the deformed or broken form rather than the standard one.

It must be emphasized that the reliable results in the pollen analysis are to be expected only on the basis of a thorough knowledge of the pollen characters. Despite many publications cited above, it is hoped to have a monograph on the pollen characters which is more complete in every respect and at the same time convenient to use. This is especially the case with us, and already led JIMBÔ (1933) to describe the pollen of some Japanese forest trees. But a number of important woody plants as well as herbaceous ones are left without any descriptions of their pollen.

The present work aims at a description of these and finally a compilation of a key for the identification of pollen for use in the pollen analysis, based upon the findings of JIMBÔ and of myself. Though the material is confined to those native to Japan, it would to some extent be applicable to European and American plants, since the difference in species must be ignored in the pollen analysis.

Among various methods hitherto suggested of making preparations from living pollen, on which criteria for the identification of the fossil pollen are based, the method devised by Jimbô (1933)[1] was employed also in the present study.

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[1] As for the inner structure and chemical properties of the exine, it is known that as a rule it consists of more than one layer and the chemical properties are comparable with those of cuticle (cf. JENTYS-SZAFER 1928).

[2],[3] Cited by CAIN (1940).

[4] Cf. JIMBÔ (1933), p. 293.

DESCRIPTION[2]

The following descriptions refer to woody and herbaceous plants of importance, exclusive of those already dealt with by Jimbô (1933).

The material was obtained from the living plants that grow in the vicinity of Sendai and on Mt. Hakkôda. Besides, through the courtesy of Dr. A. Kimura, Dr. T. Jimbô, Dr. S. Akabayashi, Dr. A. Togame, Dr. A. Miyai, Dr. A. Yoshioka and Dr. M. Tanaka, I was able to procure many specimens from various localities in our country.

Abietaceae

CEDRUS

Cedrus Libani Barrelier var. *Deodara* J. D. Hooker (ひまらやすぎ).

Identical with *Pinus*[3] except that the sculpture on the dorsal surface is more rough than in *Pinus*. 63-93μ long (inclusive of air sacs), the pollen proper being 42-63μ long and 45-60μ broad.

Podocarpaceae

PODOCARPUS

Podocarpus nagi Pilger (なぎ) (Pl. XIX, fig. 1); *P. macrophyllus* D. Don subsp. *Maki* Siebold (らかんまき).

Identical with *Pinus* except for a smaller size, 45-63μ long (inclusive of sir sacs), the pollen proper being 27-39μ long and 24-33μ broad[4].

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[1] This method consists of emptying fresh pollen by a brief treatment with concentrated HCl, so that the exine is left just as in peat, and, after evaporation of the acid by heating, adding a 10% solution of KOH, which is dried up before mounting in glycerine. Thus the artificially emptied pollen is subjected to the same treatment as that in peat.

[2] Diameter refers to that at the equator throughout the present account. In regard to some special terms used, references should be made to the next chapter entitled "Pollen types".

[3] Cf. Jimbô (1933), p. 295.

[4] Pollen with three air sacs is occasionally found in *Cedrus* and *Podocarpus*, as well as *Abies*.

Salicaceae[1]

CHOSENIA

Chosenia bracteosa (Turcz.) Nakai (けしやうやなぎ).

Identical with *Salix*[2] except for a finer reticulation (17–21 μ diameter).

TOISUSU

Toisusu Urbaniana Kimura (おほばやなぎ).

Quite identical with *Salix* (17–21 μ diameter).

Juglandaceae

JUGLANS

Juglans Allardiana Dode var. *acuta* Koidzumi (おにぐるみ) (Pl. XIX, fig. 4).

Heptagonal or octagonal in polar view, elliptic in equatorial view. Pores 7–10 (mostly 8), lacking on the ventral side invaginated when dry, one or two of them situated in the polar region and the rest at the angles on the equator, projecting; subexinous thickenings[3] more or less persistent. Exine uniform in thickness throughout. Surface indistinctly punctate. 34–42 μ diameter.

PTEROCARYA

Pterocarya rhoifolia Siebold et Zuccarini (さはぐるみ) (Pl. XIX, fig. 5).

Hexagonal or heptagonal in polar view, elliptic in equatorial view. Pores 6 7, situated at the angles on the equator, projecting; subexinous thickenings more or less persistent. Exine uniform in thickness throughout. Surface indistinctly punctate. 32–41 μ diameter.

Fagaceae

LITHOCARPUS

Lithocarpus edulis Nakai (まてばしひ).

Identical with *Castanea*[4] (9–15 μ diameter).

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[1] *Populus suaveolens* Fischer (どろのき) produces pollen quite identical with that of *P. Sieboldi* Miquel already described by Jimbô (1933, p. 295), the diameter of the former pollen measuring 19–27 μ.

[2] Cf. Jimbô (1933), p. 295.

[3] Subexinous thickenings refer to distended parts of intine developed particularly inside pores.

[4] Cf. Jimbô (1933), p. 295.

SHIIA

Shiia Sieboldi MAKINO（しひ）(Pl. XIX, fig. 11).

3-thin-areaed ("tricolpate"). A pore in each expansion fold. Surface indistinctly punctate. 12–18 μ diameter.

Nymphaeaceae

NUPHAR

Nuphar subpumilum MIKI（ねむろかはほね）(Pl. XX, fig. 1).

Ellipsoid, dorsal and ventral halves being separated by an elliptic section (this is the case with other ellipsoid pollen with a dorsi-ventrality!). 1-thin-areaed. Surface with long, sturdy, pointed spines, distributed more sparsely on the dorsal side than on the ventral. 30–45 μ long.

NYMPHAEA

Nymphaea japono-koreana NAKAI（ひつじぐさ）(Pl. XX, fig. 4).

Roundish. A thin-walled area encircling the grain. Surface punctate. 36–42 μ diameter.

Trochodendraceae

TROCHODENDRON

Trochodendron aralioides SIEBOLD et ZUCCARINI（やまぐるま）(Pl. XIX, fig. 18).

3-thin-areaed. A somewhat indistinct pore in each expansion fold. Surface very distinctly reticular (reticulation finer in the neighbourhood of expansion folds; exine uniform in thickness throughout). 15–24 μ diameter.

Eupteleaceae

EUPTELEA

Euptelea polyandra SIEBOLD et ZUCCARINI（ふさざくら）(Pl. XIX, fig. 2).

Spherical. 6-thin-areaed. Surface very finely reticular except in thin-walled areas which are roughly wrinkled. 24–33 μ diameter.

Cercidiphyllaceae

CERCIDIPHYLLUM

Cercidiphyllum japonicum SIEBOLD et ZUCCARINI（かつら）(Pl. XIX, fig. 10).

3-thin-areaed. Surface finely reticular (also in expansion folds). Exine relatively thin. 25–31 μ diameter.

Magnoliaceae

MAGNOLIA

Magnolia stellata MAXIMOWICZ（しでこぶし）(Pl. XIX, fig. 6) ; *M. Kobus* A. P. DE CANDOLLE（こぶし）; *M. obovata* THUNBERG（ほほのき).

Flattened sphere or flattened ellipsoid. 1-thin-areaed. In the first two species 27–37 and 30–39 μ long, respectively, and roughly wrinkled or roughly reticular on the dorsal side but punctate on the ventral ; in the last mentioned 60–81 μ long and with nodular protuberances on the dorsal side but punctate on the ventral.

Droseraceae

DROSERA

Drosera rotundifolia LINNAEUS（もうせんごけ）(Pl. XX, fig. 2).

United to form tetrads. Component grains are spherical and have a stalk respectively, by means of which they are connected with each other. A somewhat indistinct pore on the proximal side of each component grain. The outward surface with short spines in irregular arrangement, but the proximal spineless and thinner. Component grains 24–39 μ diameter.

Hamamelidaceae

HAMAMELIS

Hamamelis japonica SIEBOLD et ZUCCARINI（まんさく）(Pl. XIX, fig. 15).

3-thin-areaed. Surface reticular (reticulation more rough than in *Fraxinus* but less distinct). 16–24 μ diameter.

LIQUIDAMBAR

Liquidambar formosana HANCE（ふう）(Pl. XIX, fig. 9).

Spherical or ellipsoid. Thin areas more than 10 (mostly 14), arranged regularly, more or less circular, varied in size, wrinkled. Surface very finely reticular. Exine relatively thick. 27–39 μ diameter.

Malaceae

SORBUS

Sorbus commixta HEDLUND (ななかまど).

3-thin-areaed. A somewhat indistinct pore in each expansion fold. Surface indistinctly punctate. 15–24 μ diameter.

Amygdalaceae

PRUNUS

Prunus nipponica MATSUMURA (みねざくら) (Pl. XIX, fig. 17).

3-thin-areaed. A pore in each expansion fold. Surface punctate (less distinctly than in *Quercus*[1]). 24–30 μ diameter.

Euphorbiaceae

DAPHNIPHYLLUM

Daphniphyllum macropodum MIQUEL (ゆづりは); *D. humile* MAXIMOWICZ (えぞゆづりは).

3-thin-areaed. A somewhat indistinct pore in each expansion fold. Surface punctate. Exine relatively thin. 18–24 μ diameter.

Buxaceae

BUXUS

Buxus japonica MÜLLER, ARG. (つげ) (Pl. XIX, fig. 3).

Spherical. Pores about 30, irregular in arrangement. Surface finely reticular. 24–36 μ diameter.

Anacardiaceae

RHUS

Rhus trichocarpa MIQUEL (やまうるし).

3-thin-areaed. A pore in each expansion fold. Surface finely reticular. 18–24 μ diameter.

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[1] Cf. JIMBÔ (1933), p. 295.

Aquifoliaceae

ILEX

Ilex leucoclada Makino（ひめもち）(Pl. XIX, fig. 14); *I. Sugeroki* Maximowicz（あかみのいぬつげ).

3-thin-areaed. A somewhat indistinct pore in each expansion fold. Surface with well-defined irregular nodular protuberances. Exine thick. 21–30 μ diameter.

Hippocastanaceae

AESCULUS

Aesculus turbinata Blume（とちのき）(Pl. XIX, fig. 12).

3-thin-areaed. A pore in each expansion fold. Surface smooth, but in expansion folds with some granular protuberances. 12–18 μ diameter.

Araliaceae

ACANTHOPANAX

Acanthopanax sciadophylloides Franchet et Savatier（こしあぶら).

3-thin-areaed. A pore in each expansion fold. Surface finely reticular. 21–24 μ diameter[1].

Cornaceae

CORNUS

Cornus controversa Hemsley（みづき）(Pl. XIX, fig. 20).

3-thin-areaed. A pore in each expansion fold. Surface finely reticular. Exine consists of two layers and is bent inward at the margin of expansion folds. 21–27 μ diameter.

Clethraceae

CLETHRA

Clethra barvinervis Siebold et Zuccarini（りやうぶ）(Pl. XIX, fig. 16).

3-thin-areaed. A well-marked large pore in each expansion fold which is protected by two eaves projected from the both sides of the thin area as in *Fagus*. Surface smooth. 21–27 μ diameter.

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[1] This pollen and also those of *Tilia* and *Shiia* are coloured reddish brown when treated with caustic potash. Except the last named meridional plant the pollen of which has never been found in peat, a similar browning of these pollen was observed also in preparations made from peat by the routine procedure which likewise involves the treatment with caustic potash. This particular property may be of use as a diagnostic one.

Rhodoraceae

ANDROMEDA, LEDUM and OXYCOCCUS

Andromeda Polifolia Linnaeus var. *grandiflora* Lodiges (ひめしやくなげ) (Pl. XIX, fig. 13); *Ledum palustre* Linnaeus var. *nipponicum* Nakai (いそつつじ); *Oxycoccus quadripetala* Gilbert (つるこけもも).

United to form tetrahedral tetrads. Component grains themselves are 3-thin-areaed, each expansion fold of which is fused with an expansion fold of each neighbouring component grain across the common cell-wall between the both component grains. Pores 3 in each component grain, each pore situated within each expansion fold close to the separating wall. Surface indistinctly punctate. Exine relatively thick. Tetrads 30–44, 24–33 and 30–36 μ diameter in *Andromeda*, *Ledum* and *Oxycoccus*, respectively.

Symplocaceae

BOBUA

Bobua myrtacea Siebold et Zuccarini (はひのき) (Pl. XIX, fig. 8).

Trigonal in polar view, elliptic in equatorial view. Pores 3, situated at the angles; the contour of pores and the thickening of exine along them are irregular. Surface punctate. 21–33 μ diameter.

Oleaceae

FRAXINUS

Fraxinus Sieboldiana Blume var. *serrata* Nakai (こばのとねりこ) (Pl. XIX, fig. 19); *F. pubinervis* Blume (つくしとねりこ).

3-thin-areaed, occasionally 4-thin-areaed. Surface very distinctly reticular. 19–24 μ diameter.

Menyanthaceae

MENYANTHES

Menyanthes trifoliata Linnaeus (みつがしは) (Pl. XX, fig. 12).

3-thin-areaed. Surface with fine wrinkles running irregularly towards poles. Exine relatively thin throughout. 27–48 μ diameter.

FAURIA

Fauria Crista-galli MAKINO（いはいてふ）.

Identical with *Menyanthes trifoliata* except for a smaller size: 18–33 μ diameter.

Caprifoliaceae

VIBURNUM

Viburnum furcatum BLUME（むしかり）.

3-thin-areaed, expansion folds extending almost to poles. A pore in each expansion fold. Surface finely reticular (reticulation finer in the neighbourhood of the margin of expansion folds). Exine relatively thin and of an uniform thickness. 15–24 μ diameter.

WEIGELA

Weigela hortensis C. A. MEYER（たにうつぎ）(Pl. XIX, fig. 7).

Roundish in polar view, elliptic in equatorial view. Pores 3, situated on the equator, slightly projecting, exine thickens at the margin of pores. Surface with stumpy spines of an irregular size. 35–45 μ diameter.

Campanulaceae

LOBELIA

Lobelia sessilifolia LAMBERT（さはぎきやう）(Pl. XX, fig. 13).

3-thin-areaed. A somewhat indistinct pore in each expansion fold. Surface indistinctly punctate. Exine thin. 27–36 μ diameter.

Asteraceae

ARTEMISIA

Artemisia princeps PAMPANINI（かずざきよもぎ）(Pl. XX, fig. 15).

3-thin-areaed. A pore in each expansion fold. Surface with small nodular protuberances. Exine thins gradually towards the margin of expansion folds and appears radially striate in the optical section. 16–21 μ diameter.

INULA

Inula ciliaris MAXIMOWICZ（みづぎく）(Pl. XX, fig. 14).

3-thin-areaed. A pore in each expansion fold. Surface with sharply pointed, conical spines (3–3.2 μ long and 5–6 μ apart from each other). Exine very thick. 20–27 μ diameter.

Sparganiaceae

SPARGANIUM

Sparganium glomeratum Laestadius (たまみくり) (Pl. XX, fig. 8).

Ellipsoid. Pore 1. Surface reticular. Exine more or less thick. 18–27 μ long.

Scheuchzeriaceae

SCHEUCHZERIA

Scheuchzeria palustris Linnaeus (ほろむいさう) (Pl. XX, fig. 9).

Two spherical grains unite to form a dyad; also monads, triads and tetrads sometimes found. Surface very finely reticular. Component grains 18–30 μ diameter.

Poaceae

CALAMAGROSTIS and MOLINIOPSIS

Calamagrostis Matsumurae Maximowicz (むつのがりやす); *C. Langsdorfii* Trinius (いはのがりやす); *Moliniopsis japonica* Hayata (ぬまがや) (Pl. XX, fig. 5).

Roundish. Pore 1; exine thickens at the margin of the pore. Surface indistinctly punctate. 21–33 μ diameter.

Bambusaceae

SASA and SASAMORPHA

Sasa paniculata Makino et Shibata (ねまがりだけ); *Sasamorpha amabilis* Nakai (くますずたけ).

Similar to the above family, 27–42 μ diameter.

Cyperaceae

CAREX and ERIOPHORUM

Carex limosa Linnaeus (やちすげ); *C. omiana* Franchet et Savatier var. *monticola* Ohwi (かはづすげ); *C. sadoensis* Franchet (さどすげ); *Eriophorum vaginatum* Linnaeus (わたすげ) (Pl. XX, fig. 3); *E. gracile* Koch (さぎすげ).

Pear-shaped in equatorial view, roundish in polar view. At the broader end a poorly defined pore surrounded by protuberances; besides, two or three thin-walled pebbly areas on the side. Surface punctate. 30–39 μ long, 24–33 μ diameter.

Araceae

LYSICHITON

Lysichiton camtschatense SCHOTT（みづばせう）(Pl. XX, fig. 6).

Ellipsoid. 1-thin-areaed. The dorsal surface reticular, the ventral indistinctly reticular. 27–36 μ long.

Juncaceae

JUNCUS

Juncus decipiens NAKAI（ゐ）(Pl. XX, fig. 11); *J. brachyspathus* MAXIMOWICZ var. *curvatus* SATAKE（えぞほそゐ）.

United to form roundish compact tetrads, sutures between component grains distinct. Surface punctate. Outer walls thin, while septal walls thicker. Tetrads 30–45 μ diameter.

Melanthaceae

VERATRUM

Veratrum stamineum MAXIMOWICZ var. *glabrum* NAKAI（こばいけいさう）.

Ellipsoid. 1-thin-areaed. Surface reticular. 27–39 μ long.

Asphodelaceae

HOSTA

Hosta longissima HONDA var. *brevifolia* F. MAEKAWA（みづぎぼうし）(Pl. XX, fig. 7).

Ellipsoid. 1-thin-areaed. Surface with nodular protuberances. 75–99 μ long.

HEMEROCALLIS

Hemerocallis esculenta KOIDZUMI（ぜんていくわ）(Pl. XX, fig. 10).

Ellipsoid. 1-thin-areaed. The dorsal surface reticular (reticulation finer near both ends); the ventral indistinctly reticular. 47–71 μ long.

POLLEN TYPES

The simplest form of pollen is such that possesses a thin smooth exine with neither germ pores nor special delicate parts. It will readily burst on imbibition of water when put on moist places such as stigmata, and then be able to put forth pollen-tubes in any direction.

Every additional peculiarity found in the majority of pollen, which are more differentiated than such a fundamental form, is connected with any of the requirements of strengthening the wall, of putting forth pollen-tubes and of facilitating dispersion. An uniform thickening of the exine or manifold sculptures on its surface such as reticulation and wrinkles increase its strength. This in turn requires localized thin-walled areas or definite germ pores to permit germination. Lastly air sacs as well as spines are no doubt organs for dispersion.

It should also be borne in mind that the process of development of the pollen grains, which involves a tetrad stage, exerts an important effect on exine structure. The genetic significance of the dorsi-ventral character shown by many kinds of pollen has already been dealt with by previous workers. They have claimed that the usually thicker so-called dorsal side of the exine has, as a rule, been the inner wall facing to the other three cells of a tetrad. In this connection the distinct tetrahedral shape of the pollen of *Taxus* (cf. JIMBÔ 1933, p. 289) is no doubt a remnant of the tetrad stage, one of the four planes having then been the outer wall and the three others the inner.

In comparatively rare instances the union in tetrads is retained up to the maturity. This is well known as an outstanding feature of ericaceous plants and some other groups of plants. A diversity in the degree of differentiation comparable with that in the *single* pollen is found in the component grains of various *compound* pollen. Thus highly differentiated (3-thin-areaed, i. e. "tricolpate") forms occur in the ericaceous plants on one hand and a very simple one in *Juncus* on the other. The connection between the individual grains of a tetrad is mostly very close, whereas in *Drosera* they are linked with each other by mere stalks. As an intermediate form between the pollen grains united to form tetrads and those occurring singly, we may mention those of *Scheuchzeria palustris*, which occur in dyads as a rule, sometimes also in triads and tetrads, as well as singly. It is noteworthy that in this case the arrangement of individual grains is irregular so that even a chain made of four grains may occur.

Nevertheless the majority of plants produce single pollen grains, and they fall in six types as follows:

(1) *The simplest type.* This includes the simplest forms with an uniformly thin, more or less smooth exine and no germ pores. They are collapsed and cup-shaped in a dry state. This type of pollen will, in addition to the lack of distinct features, not persist long in peat and, in consequence, preclude a pollen analytical estimation of plants producing it. It is in reality responsible for a great defect of the pollen analytical method, since the pollen of some important forest trees such as *Thuja*, *Thujopsis*, etc. is of this type.

(2) *The 1-thin-areaed type.* This refers to those with a localized thin area in the exine, which occupies in general nearly a half (viz. the so-called ventral side) of the entire surface, being invaginated when dry. The dorsal thicker half in particular is characterized by a variety of sculptures.

(3) *The bladdered type.* This is a modification of the above 1-thin-areaed type. The cell itself is 1-thin-areaed, and either two (occasionally three) round air sacs (bladders) are attached laterally to the ventral side in *Pinus*, etc. or the dorsal side is fringed with a belt of air sac in *Tsuga*. The ridge likewise fringing the dorsal side of the pollen of *Larix* and *Pseudotsuga* to be ranked in the first type may be regarded as a reduced air sac.

(4) *The 3-thin-areaed type* (so-called "tricolpate"). Those which have on the equator three parallel lens-shaped thin-walled areas, often called "expansion folds", are grouped here. The latter term is based upon the fact that these thin areas are folded up in a dry state. Frequently a definite pore is formed at the middle of each expansion fold. This involves a large number of important plants whose pollen very often resembles each other, therefore skill and care are required in identifying it.

(5) *The anomalous type.* The localized thin area occurs occasionally in numbers more than three. While the pollen of *Fraxinus* shows sometimes four parallel expansion folds (4-thin-areaed), that of *Euptelea* possesses normally six thin areas situated at the positions corresponding to the six edges of a tetrahedron (6-thin-areaed) and that of *Liquidambar* has some fourteen thin areas regularly distributed. Associated with these multi-thin-areaed forms is included in this heterogeneous type a peculiar form which is encircled with a single belt of thin-walled area as in *Nymphaea*.

(6) *The perforated type.* This type of pollen grains produced by some plants of ecological importance is characterized by an uniformly thick exine with well-defined germ pores. Except such as of *Cryptomeria japonica*,

the simplest of this type of pollen, they are not only resistant but have respectively very distinct features. Hence they, associated with some members of the third and fourth types, have been the most essential objects in the pollen analyses.

In the key for the identification of pollen to be given below all kinds of pollen are classified into seven pollen types including, in addition to the above six, the compound pollen as the seventh — *the compound type*. Each of the types mentioned may be again divided into some categories.

KEY FOR IDENTIFICATION OF POLLEN

The above data together with those obtained by JIMBÔ (1933), both together involving at least the majority of pollen which will be found in our bog deposits, lacustrine sediments and raw humus soils, are condensed in the form of a key as follows.

Figures in parentheses following generic names refer to pages on which descriptions are given. Those printed in italics indicate pages in JIMBÔ's paper.

I. The simplest type.

a) Almost smooth or punctate: ***Larix*** (*290*), ***Populus*** (*295*), ***Pseudotsuga*** (*291*).

Populus		Punctate	23—30 μ diam.
Larix	Dorsal side fringed with a thickening	Smooth	75—95 μ diam.
Pseudotsuga		With indistinct fine reticulation	90–110 μ diam.

b) With minute granular protuberances: ***Cephalotaxus*** (*289*), ***Chamaecyparis, Cunninghamia*** (*291*), ***Juniperus, Thuja, Thujopsis*** (*292*).

These genera are indistinguishable (their diameters fall almost equally in a range 21–38 μ).

c) With indistinct very fine reticulation:[1] ***Taxus, Torreya*** (*289*).

Taxus	Roundish tetrahedron	20–28 μ diam.
Torreya[2]	Roundish	24–30 μ diam.

II. The 1-thin-areaed type.

a) Reticular: ***Hemerocallis, Lysichiton, Veratrum*** (502).

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[1] Cf. *Pseudotsuga* above mentioned.

[2] The pollen of *Scheuchzeria*, when occurring singly, resembles that of *Torreya*, but its exine is thinner than the latter and with a still finer reticulation (nearly punctate).

All ellipsoid.

Lysichiton	27–36 μ long	(indistinguishable)
Veratrum	27–39 μ long	
Hemerocallis	47–71 μ long	

b) With nodular protuberances:[1] ***Hosta*** (502), ***Magnolia*** (496), ***Sciadopitys*** (*291*).

Sciadopitys	Spherical	35–40 μ diam.
Magnolia stellata	Flattened sphere or flattened ellipsoid	27–37 μ long
M. Kobus		30–39 μ long
M. obovata		60–81 μ long
Hosta	Ellipsoid	75–99 μ long

c) Echinate: ***Nuphar*** (495).
Ellipsoid, 30–45 μ long.

III. The bladdered type.

a) With two lateral air sacs: ***Abies*** (*290*), ***Cedrus*** (493), ***Picea*** (*290*), ***Pinus*** (*289*), ***Podocarpus*** (493).

	Inclusive of air sacs	Exclusive of air sacs	
	Length in μ	Length in μ	Breadth in μ
Podocarpus	45–63	27–39	24–33
Pinus	60–85	40–62	30–50
Cedrus	63–93	42–63	45–60
Picea	100–120	75–90	60–75
Abies	125–140	85–105	75–90

Cedrus similar to *Pinus* in size may be distinguished from the latter by a more rough sculpture on the dorsal surface.

b) With a belt of air sac: ***Tsuga*** (*290*).
55–100 μ diam. (inclusive of air sac).

IV. The 3-thin-areaed type ("tricolpate").

a) Smooth: ***Aesculus*** (498), ***Castanea*** (*295*), ***Clethra*** (498), ***Lithocarpus*** (494), ***Lobelia*** (500), ***Shiia*** (495), ***Sorbus*** (497).

Lithocarpus and *Castanea* are indistinguishable. *Aesculus* is characterized by granular protuberances on the thin areas in expansion folds, *Shiia* by the browning by KOH, *Clethra* by particularly large pores in each expansion fold protected by two lateral eaves. *Lobelia* by its larger size.

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[1] In *Magnolia stellata* and *M. Kobus* the dorsal surface is roughly wrinkled or roughly reticular.

Lithocarpus	9–15 μ diam.
Castanea	10–16 μ diam.
Aesculus *Shiia*	12–18 μ diam.
Sorbus	15–24 μ diam.
Clethra	21–27 μ diam.
Lobelia	27–36 μ diam.

b) Punctate: **Daphniphyllum** (497), **Fagus** (294), **Prunus** (497), **Quercus** (295).

Fagus is characterized by highly differentiated expansion folds, each of which involves a well-defined pore with a marginal thickening and is protected by two eaves projected from the both sides of the thin area. *Prunus* shows a punctate sculpture less distinct in comparison with *Quercus*. *Daphniphyllum* has a relatively thin exine.

Daphniphyllum	18–24 μ diam.
Prunus	24–30 μ diam.
Quercus	23–35 μ diam.
Fagus	32–45 μ diam.

c) With fine wrinkles running towards the poles: **Acer** (295), **Fauria** (500), **Menyanthes** (499).

Acer	Exine thins towards expansion folds	18–28 μ diam.	
Fauria	Exine relatively thin throughout	18–33 μ diam.	(scarcely distinguishable)
Menyanthes		27–48 μ diam.	

d) Finely reticular: **Acanthopanax** (498), **Cercidiphyllum** (496), **Cornus** (498), **Rhus** (497), **Viburnum** (500).

Viburnum is characterized by a reticulation which is finer in the neighbourhood of expansion folds, *Acanthopanax* by the browning by KOH, *Cornus* by a twofold stratification of exine, *Cercidiphyllum* by a fine reticulation on the thin areas in expansion folds. Moreover *Viburnum* and *Cercidiphyllum* have relatively thin exine.

Viburnum	15–24 μ diam.
Rhus	18–24 μ diam.
Acanthopanax	21–24 μ diam.

Cornus	21–27 μ diam.
Cercidiphyllum	25–31 μ diam.

e) Reticular: ***Chosenia*** (494) ***Fraxinus*** (499), ***Hamamelis*** (496), ***Salix*** (295), ***Toisusu*** (494), ***Trochodendron*** (495).

	Thickness of exine	Reticulation	Diameter in μ
Hamamelis	Uniform	Uniform, rough	16–24
Fraxinus		Uniform, very distinct	19–24
Trochodendron		Finer in the neighbourhood of expansion folds, very distinct	15–24
Chosenia	Thins towards expansion folds	Finer in the neighbourhood of expansion folds	14–25
Salix			
Toisusu			

Chosenia may be distinguished from the other salicaceous genera by a finer reticulation.

f) With small nodular protuberances: ***Artemisia*** (500).
Exine thins twards expansion folds, 16–21 μ diam.

g) With well-defined nodular protuberances: ***Ilex*** (498).
21–30 μ diam.

h) Echinate: ***Inula*** (500).
20–27 μ diam.

V. The anomalous type.

a) With more than three thin areas: ***Euptelea*** (495), ***Liquidambar*** (496).
Both spherical or ellipsoid and very finely reticular.

	No. of thin areas	Diameter in μ
Euptelea	6	21–33
Liquidambar	ca. 14	27–39

b) With a belt of thin area: ***Nymphaea*** (495).
Roundish, punctate, 36–42 μ diam.

VI. The perforated type.

a) Almost smooth: ***Alnus*** (292), ***Betula*** (293), ***Calamagrostis*** (501), ***Carpinus, Celtis, Corylus*** (293), ***Juglans*** (494), ***Moliniopsis*** (501), ***Ostrya***

(*293*), ***Pterocarya*** (194), ***Sasa, Sasamorpha*** (501).

	No. of pores	Shape	Margin of pores	Diameter in μ
Calamagrostis *Moliniopsis* *Sasa* *Sasamorpha*	(gramineous) 1	Roundish	Thickened	21–42
Betula	3 (occasionally 4)	Polygonal	Dichotomous in section, projecting.	20–35
Corylus	3		Thickened with no dichotomy, slightly projecting	25–30
Carpinus *Ostrya*	3–4 (occasionally 5)	Roundish	With no thickening, projecting (exine relatively thin)	23–35
Celtis	3(occasionally 4)	Circular	Slightly thickened	24–30
Alnus	4–6	Polygonal	Dichotomous in section, projecting	20–30
Pterocarya	6–7		With no thickening, projecting (sometimes with subexinous thickening)	32–44
Juglans	7–10 (mostly 8), mostly on the equator, 1–2 in a polar region			34–42

b) Punctate: ***Bobua*** (499), ***Carex, Eriophorum*** (501).

Bobua: trigonal, with 3 pores of irregular forms, the margin of which irregularly thickened, 21–33 μ diam.

Carex and *Eriophorum* (both cyperaceous): pear-shaped, with 1 pore at the broader end, also 2 or 3 thin-walled pebbly areas on the side, 24–33 μ diam.

c) With small granular protuberances: ***Cryptomeria*** (*291*).

Spherical, with 1 pore surrounded by a ligulate projection from exine, 30–35 μ diam.

d) Reticular: ***Buxus*** (497), ***Sparganium*** (501), ***Tilia*** (*294*).

	No. of pores	Shape	Surface	Diameter in μ
Sparganium	1	Ellipsoid	Reticular	18–27
Tilia	3	Somewhat trigonal	Very finely reticular	30–37
Buxus	ca.30	Spherical	Finely reticular	24–36

e) Very roughly wrinkled or very roughly reticular: *Ulmus, Zelkowa* (*294*).

	No. of pores	Shape	Margin of pores	Diameter in μ
Ulmus	4–5 (occasionally 6)	Roundish	Slightly thickened	23–33
Zelkowa	4–5	Polygonal	Considerably thickened	35–40

f) Echinate: ***Weigela*** (500).

Roundish, with 3 pores, the margin of which thickened and slightly projecting, 35–45 μ diam,

VII. The compound type.

a) Tetrad: ***Andromeda*** (499), ***Drosera*** (496), ***Juncus*** (502), ***Ledum***, ***Oxycoccus*** (499).

		Component grain	Diameter in μ
Andromeda *Ledum* *Oxycoccus*	(ericaceous)	3-thin-areaed, indistinctly punctate	24–44 (tetrad)
Juncus		Of the simplest type, punctate, thin-walled	30–45 (tetrad)
Drosera		Connected by stalks, echinate	24–39 (component grain)

b) Dyad in general: ***Scheuchzeria*** (501).

Component grain: of the simplest type, very finely reticular, 18–30 μ diam.

SUMMARY

For use in pollen analysis the pollen-grain characters are described and illustrated of 65 species of woody and herbaceous plants falling in 51 genera and 36 families. Finally a key for the identification of pollen is given, which is based upon these data and the findings of JIMBÔ (1933), both together including the majority of plants that are important to pollen analyses.

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LITERATURE

Bertsch, K. (1931). Paläobotanische Monographie des Federseerieds. *Bibl. Bot.*, **26**, 103:1.

Cain, S. A. (1940). The identification of species in fossil pollen of *Pinus* by size-frequency determinations. *Amer. Jour. Bot.*, **27**, 301.

Dokturowsky, W., und Kudrjaschow, W. (1923). Schlüssel zur Bestimmung der Baumpollen im Torf. *Geol. Arch.*, **3**, 180.

Erdtman, G. (1921). Beitrag zur Kenntnis der Mikrofossilien in Torf und Sedimenten. *Ark. Bot.*, **18**, 14:1.

(1936) New methods in pollen analysis. *Sv. Bot. Tidsk.*, **30**, 154.

Hansen, H. P. (1938). Postglacial forest succession and climate in the Puget Sound Region. *Ecology*, **19**, 528.

(1939 *a*). Pollen analysis of a bog in northern Idaho. *Amer. Jour. Bot.*, **26**, 225.

(1939 *b*). Paleoecology of a central Washington bog. *Ecology*, **20**, 563.

Heimsch, C. Jr. (1940). Wood anatomy and pollen morphology of *Rhus* and allied genera. *Jour. Arn. Arb.*, **21**, 279.

Hörmann, H. (1929). Die pollenanalytische Untersuchung von *Pinus montana*, *P. silvestris* und *P. cembra*. *Österr. Bot. Zeitschr.*, **78**, 215.

Jentys-Szafer, J. (1928). La structure des membranes du pollen de *Corylus*, etc. *Bull. Int. Acad. Pol. Sci. Lett. Cl. Sci. Math. Nat.* Sér. B. Bot., **1928**, 76.

Jimbô, T. (1933). The diagnoses of the pollen of forest trees. I. *Sci. Rep. Tôhoku Imp. Univ.* Ser. 4, **8**, 287. [Also in Japanese: *Ecol. Rev.*, **1**, 91 (1935)].

Kirchheimer, F. (1934). Über *Tsuga*-Pollen aus dem Tertiär. *Planta*, **22**, 171.

Meinke, H. (1927). Atlas und Bestimmungsschlüssel zur Pollenanalytik. *Bot. Arch.*, **19**, 380.

Potonié, R. (1934). Zur Mikrobotanik der Kohlen und ihrer Verwandten. *Arb. Inst. Paläobot. Petrogr. Brennsteine*, **4**, 1.

Rudolph, K. (1935). Mikrofloristische Untersuchung tertiärer Ablagerungen im nördlichen Böhmen. *Beih. Bot. Centralbl.*, **54**, B, 244.

und Firbas, F. (1925). Die Hochmoore des Erzgebirges. *Beih. Bot. Centralbl.*, **41**, II, 3.

Sears, P. B. (1930). Common fossil pollen of the Erie Basin. *Bot. Gaz.*, **89**, 95.

Stark, P. (1927). Über die Zugehörigkeit des Kieferpollens in den verschiedenen Horizonten der Bodenseemoore. *Ber. Deutsch. Bot. Ges.*, **45**, 40.

Trela, J. (1928). Zur Morphologie der Pollenkörner der einheimischen *Tilia*-Arten. *Bull. Int. Acad. Pol. Sci. Lett. Cl. Sci. Math. Nat.* Sér. B. Bot., **1928**, 45.

Wassink, E. C. (1932). Abbildungen von Baumpollen aus dem Torf. *Rec. trav. bot. néerl.*, **29**, 15.

Wodehouse, R. P. (1935). Pollen grains. New York and London.

Yamazaki, T. (1933). Morphology of pollen grains and spores (in Japanese). *Rep. Exp. Forest Kyôto Imp. Univ.*, 5.

EXPLANATION OF PLATES XIX and XX

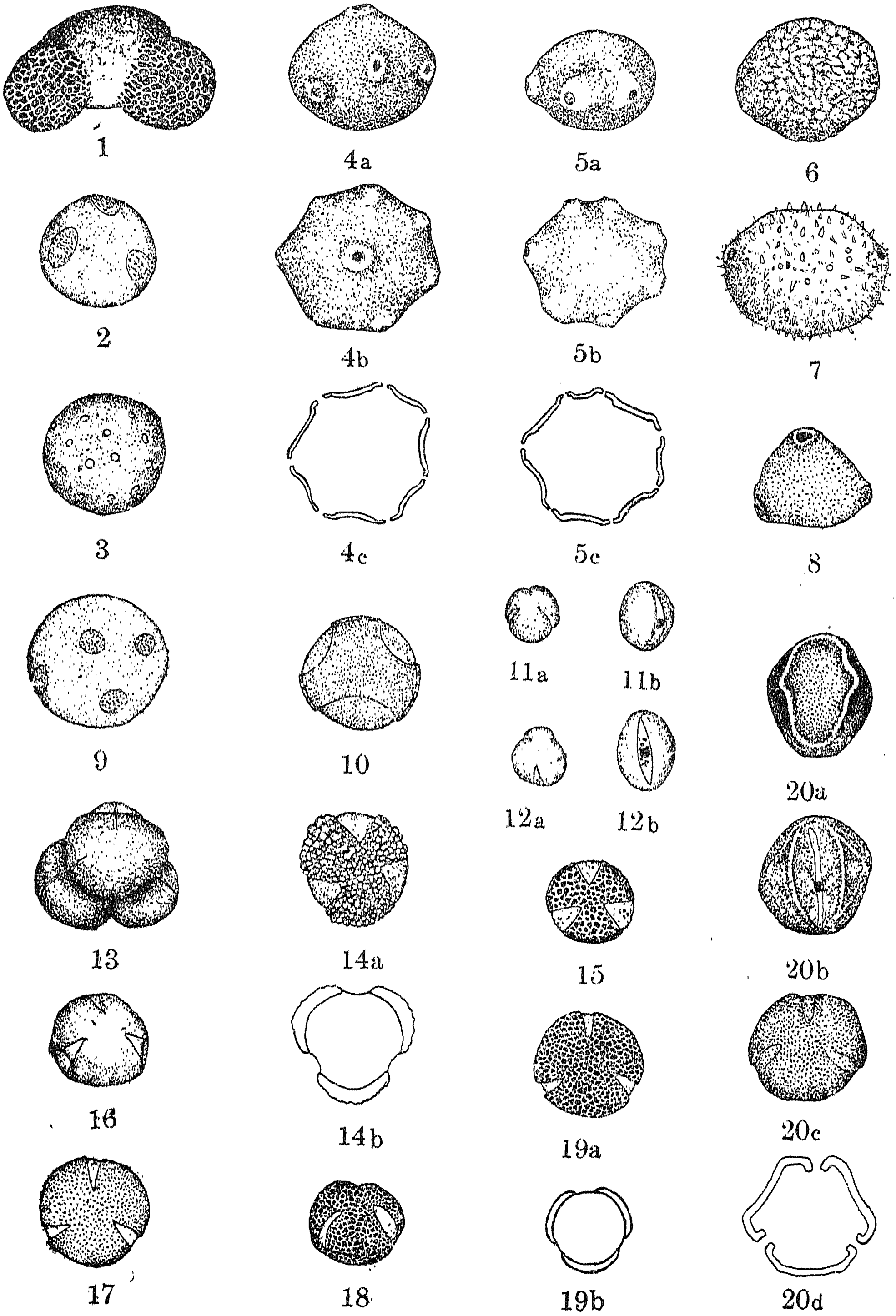
Magnification of figures is ×569.

PLATE XIX

Fig. 1. *Podocarpus nagi.*
Fig. 2. *Euptelea polyandra.*
Fig. 3. *Buxus japonica.*
Fig. 4. *Juglans Allardiana* var. *acuta*: *a*, equatorial view; *b*, dorsal view: *c*, equatorial section.
Fig. 5. *Pterocarya rhoifolia*: *a*, equatorial view; *b*, dorsal view; *c*, equatorial section.
Fig. 6. *Magnolia stellata*: dorsal view.
Fig. 7. *Weigela hortensis.*
Fig. 8. *Bobua myrtacea.*
Fig. 9. *Liquidambar formosana.*
Fig. 10. *Cercidiphyllum japonicum.*
Fig. 11. *Shiia Sieboldi*: *a*, polar view; *b*, equatorial view
Fig. 12. *Aesculus turbinata*: *a*, polar view; *b*, equatorial view.
Fig. 13. *Andromeda Polifolia* var. *grandiflora.*
Fig. 14. *Ilex leucoclada*: *a*, polar view; *b*, equatorial section.
Fig. 15. *Hamamelis japonica.*
Fig. 16. *Clethra barvinervis.*
Fig. 17. *Prunus nipponica.*
Fig. 18. *Trochodendron aralioides.*
Fig. 19. *Fraxinus Sieboldiana* var. *serrata*: *a*, polar view; *b*, equatorial section.
Fig. 20. *Cornus controversa*: *a*, and *b*, equatorial view (in *a*, two expansion folds are not manifestly shown being hidden by the bends of exine); *c*, polar view of a fully expanded grain; *d*, equatorial section.

PLATE XX

Fig. 1. *Nuphar subpumilum*: dorsal view.
Fig. 2. *Drosera rotundifolia.*
Fig. 3. *Eriophorum vaginatum.*
Fig. 4. *Nymphaea japono-koreana*: equatorial view.
Fig. 5. *Moliniopsis japonica.*
Fig. 6. *Lysichiton camtschatense*: *a*, dorsal view; *b*, ventral view.
Fig. 7. *Hosta longissima* var. *brevifolia*: dorsal view.
Fig. 8. *Sparganium glomeratum.*
Fig. 9. *Scheuchzeria palustris*: a dyad.
Fig. 10. *Hemerocallis esculenta*: dorsal view.
Fig. 11. *Juncus decipiens.*
Fig. 12. *Menyanthes trifoliata.*
Fig. 13. *Lobelia sessilifolia.*
Fig. 14. *Inula ciliaris*: polar view.
Fig. 15. *Artemisia princeps.*



1 4a 5a 6
2 4b 5b 7
3 4c 5c 8
9 10 11a 11b 12a 12b 20a
13 14a 15 20b
16 14b 19a 20c
17 18 19b 20d

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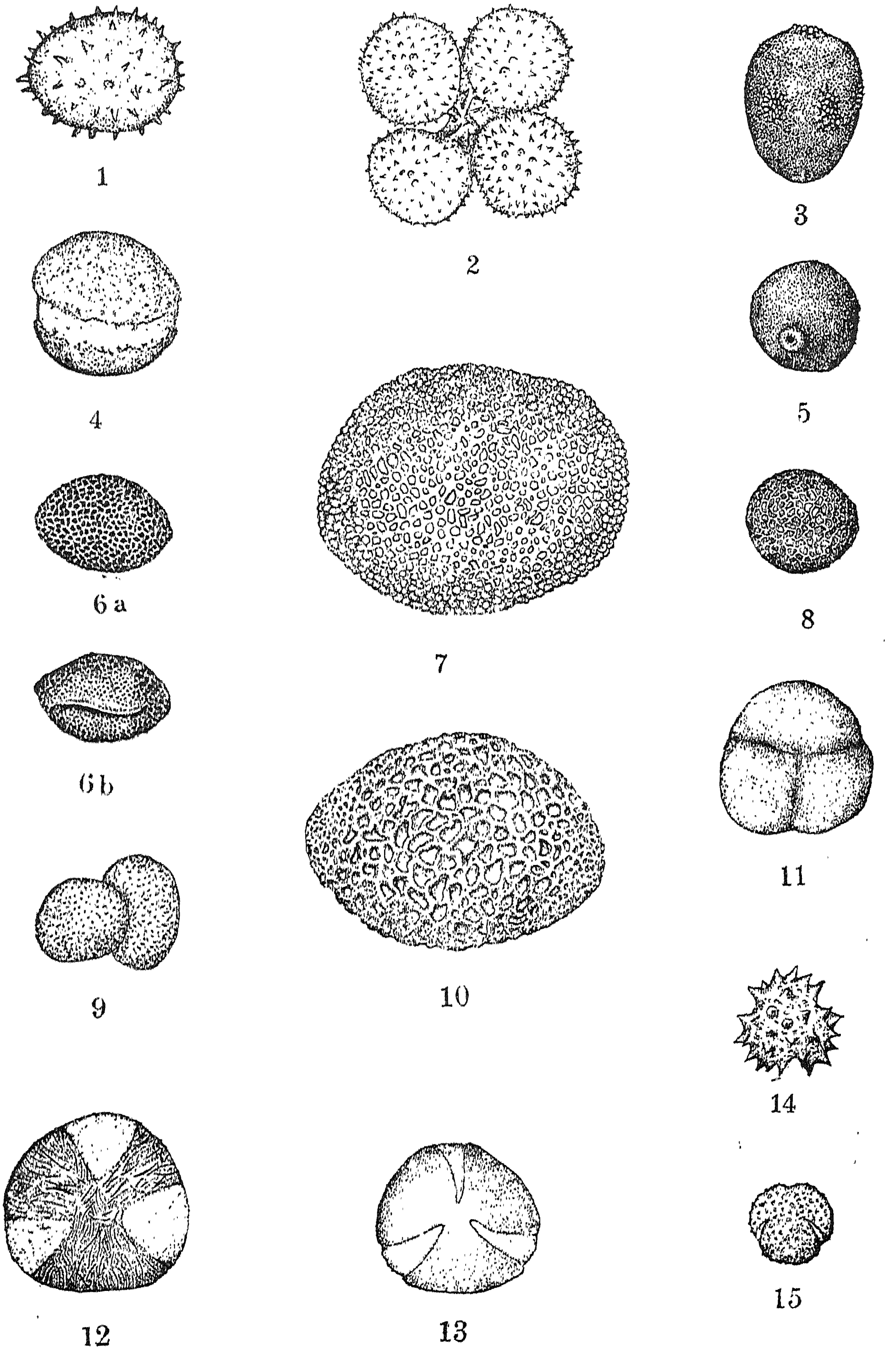

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